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Ministry of New and
Renewable Energy
Government of India

Volume 5 ■ Issue 1 ■ August 2011

Renewable Energy
Akshay Urja

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Renewables in North Eastern Region

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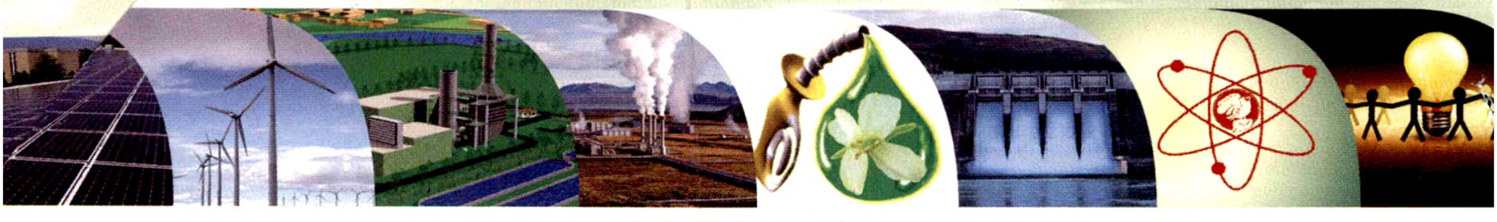

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Renewable Energy
Akshay Urja

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Cover Photo: Collage of various pictures displaying the renewable energy applications in North Eastern Region.

Disclaimer: The views expressed by authors including those of the editor in this newsletter are not necessarily the views of the MNRE.

From the Editor's Desk

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Dear Readers,

'Unity in diversity' has been a motto for India and underlines the fact that the country is indeed a land of the diverse - be it the geography, people, language, culture… the list could go on. And no more is this diversity more obvious than in the north eastern part of the country. Though clubbed together as the north eastern region (NER) each of the eight states - Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura - is unique in its own way.

The states are blessed with abundant natural resources and have a tremendous potential for the utilisation of renewable energy (RE). Recognising this, the Ministry of New and Renewable Energy (MNRE) has been giving a special focus to the region as a whole and each state individually through a separate budget allocation of about 10 per cent under various renewable energy programmes. The NER is also provided higher rates of central financial assistance, normally up to 90 per cent in most of the cases. Dr Farooq Abdullah, Minister of New and Renewable Energy called upon the power ministers of the north eastern states to maximise the use of RE and to review the implementation of RE polices and programmes in the NER in a meeting on 2 July 2011 in New Delhi. The enthusiasm and commitment expressed by all ministers towards use of renewable energy is quite encouraging.

The NER is a true 'frontier' - each state shares part of the over 2000 km border with Bhutan/China/Myanmar or Bangladesh and is connected to the rest of India only by a narrow 20 km wide corridor of land. The remote village electrification (RVE) programme of MNRE has energised 2392 remote villages and hamlets mostly in the border areas. Seven cities namely Agartala, Kohima, Jorhat, Guwahati, Imphal, Itanagar and Dimapur are also being developed as solar cities. The Prime Minister's special package of about Rs 550 crores for illumination/electrification of households/villages located in the international border districts of Arunachal Pradesh through a mix of RE technologies mainly solar, small hydro and biomass is also being implemented by MNRE.

In this issue, we bring you glimpses of each state from a renewable perspective. The potential and implementation in each state may seem 'small' when compared to the rest of the country; a closer look will help the readers understand the reasons and constraints faced by the people in the region.

I invite all readers and those who are concerned about renewable energy to share their views and experiences with us to help us expand the scope and reach of Akshay Urja, and hope that the readers will enjoy this issue.

Happy reading.

अक्षय ऊर्जा से देश विकास

A Tripathi

ARUN K TRIPATHI
<aktripathi@nic.in>

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Letters to the Editor

We are a company dealing with a range of solar photovoltaic systems. Akshay Urja newsletter is very educative and a great help to organisations like ours to broaden our awareness on new technologies, renewable energy, latest news in the field and much more.

Anurag Srivastava, Engineer,
Jay Ushin Limited,
Gurgaon, Haryana.

I teach the subject 'non conventional energy sources' in our college. I appreciate the Akshay Urja newsletter because it helps me to supplement my teaching. I have found the newsletter interesting and informative and hope that it will continue to publish about the latest development in various areas of renewable energy.

Deba Kumar Mahanta,
Assistant Professor,
Assam Engineering College,
Guwahati, Assam.

I am an architect working for an organisation providing consultancy for Green Buildings, I would like to receive a copy of the Green Buildings special issue of Akshay Urja (Volume 4: Issue 5).

Chitra Chidambaram,
Regional Manager,
ICMQ India, New Delhi.

I would like to congratulate you for editing a very useful and educative newsletter, which meets the needs of the time. This is the first time I have read Akshay Urja and found that it incorporates articles from eminent authors in the field and other information is also explicitly presented. I would humbly like to make a suggestion - please include the latest achievements of each state in the renewable energy field in each issue of the newsletter.

Dr AN Arora, Professor,
Kautilya Institute of Technology
and Engineering,
Jaipur, Rajasthan

I am very much interested in renewable energy, particularly solar energy and wish to become a part of the solar industry. I had a chance to read Akshay Urja recently and found it interesting and very informative.

Shivali Pandya Thakar,
Mumbai, Maharashtra.

We are a company based in Bihar and are working in renewable energy sector. Akshay Urja newsletter keeps us updated with the latest in the field of renewable energy.

Anil Mandal,
Ripal Energy India Pvt. Ltd.,
Patna, Bihar.

I would like to subscribe to Akshay Urja newsletter to know more about the applications of renewable energy, to develop some research programmes. Our field is the design and development of circuitry, which requires low voltage power sources, like satellite payloads.

Sunil Singh, Sr. Technical
Assistant-A (RF& MW),
Space Applications Centre,
Ahmadabad, Gujarat.

अक्षय ऊर्जा का अप्रैल 2011 का अंक प्राप्त हुआ, आपको कोटि–कोटि धन्यवाद। 'सौर ऊर्जा' के बारे में अच्छी जानकारी प्राप्त हो जाती है। संस्था 'सौर ऊर्जा' की लालटेन, एवम् यंत्रों का कार्य करना चाहती है। कृप्या कम्पनियों का पता भेजने की कृपा करें जिनसे सम्पर्क किया जा सके।

श्रीमती अंजलि रस्तोगी, अध्यक्ष,
अरविन्द महिला विकास क्लब समिति,
बुदौन, उत्तर प्रदेश

अक्षय ऊर्जा अप्रैल 2011 का अंक प्राप्त हुआ। इस अंक में हरित भवनों के निर्माण से संबंधित किया गया विश्लेषण बहुत अच्छा लगा। आज के ग्लोबल वार्मिंग के खतरे को देखते हुए पर्यावरण को बचाने के लिए इस तरह की पहल बहुत ही प्रशंसनीय है। इस तरह की पहल से न केवल पर्यावरण का संरक्षण और संवर्धन होगा बल्कि आने वाली पीढ़ी को भी फायदा होगा जिससे उनका भविष्य सुरक्षित हो सकेगा। इस अंक में इसके अलावा हरित परिसर के बारे में लोगों में जागृति फैलाने की दृष्टि से प्रस्तुत किया गया आलेख खास लगा।

बी. एस मिरग, पब्लिक रिलेशन ऑफिसर,
महात्मा गांधी अंतरराष्ट्रीय विश्वविद्यालय,
वर्धा, महाराष्ट्र

हरित भवन विशेषांक पढ़ा। अत्यधिक रोचक एवं ज्ञानवर्धक लगा। अक्षय ऊर्जा के प्रचार एवं प्रसार के क्षेत्र में आपके द्वारा किया जा रहा कार्य अति सराहनीय है, एवं आपको उसके लिए बधाई देना चाहते हैं। स्वच्छ एवं हरित ऊर्जा के क्षेत्र में रोजगार की भी विपुल संभावनाएं हैं, कृपया एक विशेषांक इस पर भी निकालें तो हम विद्यार्थियों के लिए भविष्य संवारने में भी मदद मिलेगी। हमारी शुभकामनाएं आपके साथ हैं।

उत्पलकान्त
बनारस हिन्दु विश्वविद्यालय,
वाराणसी, उत्तर प्रदेश

Dear Reader, Thank you very much for your encouragement. The editorial team of Akshay Urja will make every effort to make this newsletter highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvements in terms of content and presentation. **Editor: Akshay Urja**

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Manipur Renewable Energy Development Agency has achieved installed capacity of about 3 MW till 31 March 2011, through solar PV, small hydel, wind-solar hybrid, biomass, solar thermal etc.

The Sikkim Renewable Energy Development Agency has been striving to keep itself updated and has been putting together all efforts to etch a name for itself in the RE sector in the country.

SHL systems have been installed and commissioned by Tripura Renewable Energy Development Agency at hamlets/villages where grid power is not available and is not likely to reach in the near future.

Dr Farooq Abdullah calls upon Power Ministers of North Eastern States to maximize use of renewable energy

Minister of New and Renewable Energy, Dr Farooq Abdullah reviewed the implementation of renewable energy polices and programmes in the North Eastern States at a meeting in New Delhi on 2nd July 2011. The meeting was attended by the Chief Minister of Meghalaya and the Power Ministers of other North Eastern States, senior officials from the Ministry and the State governments.

It was informed during the meeting that out of 4,965 remote villages to be electrified/ illuminated through renewable energy systems in the region, 3,841 villages have already been provided solar lights. There are over 160 small/ micro hydel projects installed in the North Eastern States with 275 MW aggregate capacity. Apart from this, over 60,000 solar lanterns, home lighting systems and street lights have been set up. The region has over 1,18,000 biogas plants. The Ministry is now making a detailed assessment of wind resources in the North East. Arunachal Pradesh is implementing a special project to electrify/ illuminate all its villages along the international border through solar and micro hydel projects. Out of 1058 target villages under this project, 736 villages have already been covered.

Dr Abdullah appreciated the difficulties faced by the North Eastern States and assured them all possible help from the Ministry. The States agreed to take action to strengthen the renewable energy programme. Power Ministers from the North Eastern States requested for 90 per cent funding from the Ministry of New and Renewable Energy for the renewable energy projects in the region. They also requested for help in preparation of State specific action plans for renewable energy. Dr Abdullah agreed to get the resource mapping for solar, wind and micro/ small hydro prepared for these States. The States in the region have also been advised to put in more efforts for popularisation of renewable energy for maximising the use of these technologies. The Ministers and concerned officers of North Eastern States will be given opportunities to visit showcase projects within and outside the country.

Power Ministers from North Eastern States appreciated the leadership provided by Dr Farooq Abdullah in promoting renewable energy in the country especially in the North Eastern States and new policies under Jawaharlal Nehru National Solar Mission.

http://pib.nic.in, 2 July 2011

Secretary MNRE Inaugurates Administrative Block of SSS-NIRE

Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE), at Wadala Kalan, District Kapurthala (Punjab) is an autonomous institution of the Ministry of New and Renewable Energy, Govt. of India It is spread over a sprawling campus of about 75 acres. The Institute is marching towards developing into a centre of excellence in the biomass energy. The Institute is to conduct the-state-of-the-art research, design and development activities in all the areas of biomass energy, bio-fuels, synthetic fuels and new technologies. The Governing Council under the Chairmanship of Secretary, Ministry of New and Renewable Energy has been directing and monitoring the progress of the Institute. The Secretary,

Shri Deepak Gupta inaugurated the Administrative Block of the Institute on 15th July, 2011.

Solkar makes colleges go green

In its silver jubilee year Solkar has installed and commissioned 10 kW solar power plants at two colleges in Tamilnadu. The plants installed at DG Vaishnav College, Chennai and the PSG College of Technology, Coimbatore are capable of generating 50 units per day and can back up the loads of the lights, fans, computers, printers, fax machines, televisions, EPBX box and all other regular electrical appliances. The system comes with a data logger and has helped the colleges save handsomely on their electricity bills. Solkar plans to install such systems in 50 other institutions.

www.solkar.in, June 2011

Gujarat to host Asia's largest solar energy park

Gujarat would house the largest solar energy park in Asia in two years, with a power production capacity of 500 MW. This would be set up with an investment of around Rs 8,000 crore flowing from companies such as GMR and Lanco, which have been assigned generation capacities under the Gujarat Solar Mission. Gujarat had announced a solar power policy in January 2009, with a target of installing 1,000 MW capacity by 2012 and 3,000 MW by 2014. The state has already signed power purchase agreements (PPAs) for 934 MW.

The park, on the lines of an industrial estate, is being developed by Gujarat Power Corporation Ltd (GCPL), as the sectoral nodal agency, on around 2,000 hectares of wasteland bordering the Rann of Kutch, in Patan district. When commissioned, the project would provide 800 million units of power. In the first phase, 15 solar power generation companies would produce 176 MW and Gujarat Energy Transmission Corporation would set up a power pooling station. The overall project cost in phase I would be Rs 1287 crore. This would include Rs 351 towards the cost of land and power infrastructure and Rs 624 crore for evacuation facilities.

The Planning Commission has already approved a one-time additional central assistance of Rs 210 crore for the development of the solar park. The Asian Development Bank has approved a soft loan of USD 100 million for the project. This includes development of a 'smart grid' for evacuation of power.

www.business-standard.com, 29 June 2011

IIT-Delhi and Aston setting up green plant to run fruit processing units

Business and engineering academics from Aston University, UK, and the Indian Institute of Technology (IIT), Delhi, are overseeing the construction of a combined heat and power plant (CHP) that will provide heat, steam and electricity to rice mill, fruit and vegetable processing plants and water distillation unit in a remote village in northern India. Fuelled by crop waste such as rice husks and prosopis wood, the 300 kW biomass-solar plant is being built as part of a three year project. The combination of solar and biomass power will reduce fuel consumption while allowing round-the-clock operation of the mill, processing plants and distillation unit.

The plant will allow regional farmers and their families to access a cheap, renewable and reliable energy source that in-turn can help remote villages to generate an income and escape from a cycle of 'fuel poverty'. The research team wants to use this pioneering project to create a blueprint for renewably-powered CHP boilers, capable of being replicated throughout India.

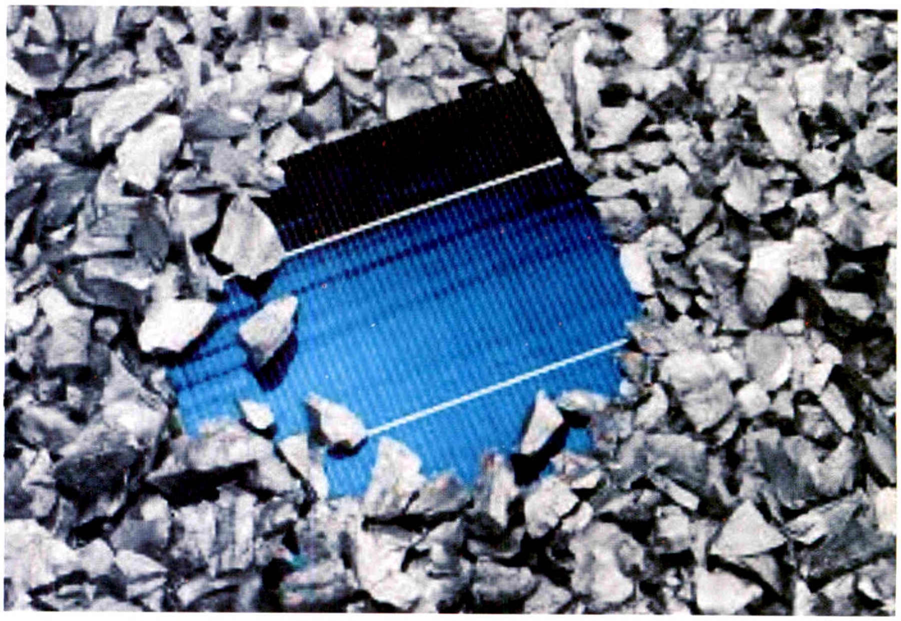
www.fnbnews.com, 29 June 2011

Indian Oil seeks Khosla-backed ethanol technology with Jindal

Indian Oil Corporation and Jindal Steel & Power Ltd. (JSP) are in talks to produce ethanol from waste gases using a technology backed by billionaire Vinod Khosla as India seeks to boost the use of green fuels amid rising crude prices. The two companies are seeking to build a commercial-scale ethanol plant with technology from LanzaTech, which uses microbes to convert industrial pollutants such as carbon monoxide into biofuels.

Waste gases from a Jindal steel plant could be used to produce the green fuel for blending with Indian Oil's gasoline pool. India introduced

a national biofuel policy in 2008 to counter the rising costs of oil imports to meet 80 per cent of domestic needs. The policy requires refiners to blend gasoline for a 10 per cent ethanol content and proposes to raise that to 20 percent by 2017. A shortage of sugar-based ethanol in the country has made it difficult for companies to comply with those regulations.
www.bloomberg.com, 29 June 2011



City heritage sites tap sun's power, electricity bills dip

The solar panels at Jantar Mantar and Safdarjung's Tomb in New Delhi have helped slash the electricity bills of these centrally protected monuments almost by half. The Archaeological Survey of India (ASI) is now thinking of expanding the initiative and installing solar panels at 11 other heritage sites in the capital. The panels at these two heritage sites were installed around six months ago, following an initiative of the ASI and the Ministry of New and Renewable Energy (MNRE).

The power bill for Jantar Mantar has seen a dip of Rs 5,000 per month i.e. from monthly Rs 15,000 to Rs 10,000. At Safdarjung's Tomb, where ASI also has an office, the bill was reduced from Rs 34,000 to Rs 25,000 per month. The daytime load at all heritage sites includes indoor lighting and fans, ventilation, solar photovoltaic pumps for irrigation, information kiosks and supply at the ticketing counters. The night load includes LED-based floodlights, garden and outdoor lights.
www.indianexpress.com, 28 June 2011

Lanco Infra to invest Rs 1,700 crore in solar units

Lanco Solar Energy plans to infuse Rs 1700 crore for the second phase of India's first integrated solar photovoltaic (PV) manufacturing special economic zone (SEZ) project in Rajnandgaon district of Chhattisgarh. The investment will be used to manufacture polysilicon, ingots, wafers, PV cells and modules with capacities equivalent to 250 MW per year, said V Saibaba, CEO, Lanco Solar Energy.

The SEZ project, which commenced four months ago, is being developed in phases to put Chhattisgarh in the global map of polysilicon production bases. The first phase of the project, which involved an investment of Rs 1340 crore, will be fully operational in a couple of months. Moreover, the company is also strengthening its global market and plans to build solar farms in Germany, France, Italy, the US and the UK where it is already offering engineering, procurement and construction (EPC) solutions.
www.hindustantimes.com, 28 June 2011

Ushdev may seek India wind farm acquisitions to boost capacity

The clean-energy unit of Ushdev International Ltd. may seek to acquire wind farms to boost its capacity 10-fold by 2014. Ushdev Power Holdings plans to invest 18 billion rupees to add 100 MW of wind energy capacity annually over the next three years. By 2018, Ushdev Power may seek to build as much as 1000 MW of renewable energy capacity, which could also include solar, hydropower and biomass plants. Mumbai-based Ushdev Power currently owns 30.5 MW of wind farms in six different states that use turbines made by Denmark's Vestas Wind Systems A/S, as well as Germany's Enercon GmbH and Kenersys GmbH.

www.bloomberg.com, 28 June 2011

India plans 550 MW of concentrated solar power by 2013

German technologists and researchers have developed high efficiency solar technologies suitable for countries in the so-called sun belt, such as India. Solar photo voltaic (PV) technology has been used for long to generate power from the sun. However, its use has remained limited because of its low efficiency and other constraints. Now, concentrated solar power (CSP) is emerging as a viable alternative.

One of the biggest benefits of CSP is its ability to store thermal heat, which ensures continuous supply of power even when the sun is down and when it gets cloudy. India, with plans to install 550 MW of CSP by 2013, could emerges a major player in this area. The Jawaharlal Nehru National Solar Mission recognises CSP as a key source of renewable power. The Ministry of New and Renewable Energy (MNRE) is setting up a string of demonstration projects. A 10 MW CSP plant is already under construction near Bikaner by ACME, a private company.

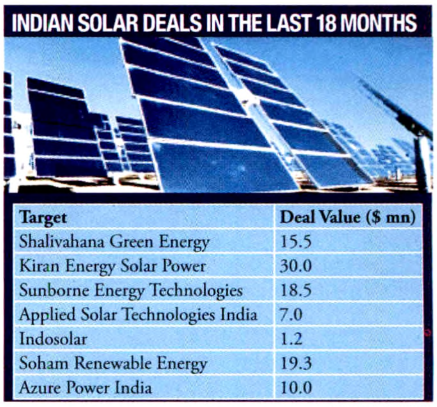
According to MNRE, CSP could be an attractive option for the country, given the fact that large areas of northwest India fall in the high radiation zone. The costs can be brought down if concentrating mirrors and receiving tubes are manufactured locally.

http://indiatoday.intoday.in, 1 July 2011

Suzlon receives 50.4 MW order from NALCO

Suzlon Energy Limited announced a new order from the National Aluminium Company Limited (NALCO) to set up, operate and maintain 50.4 MW of wind energy projects in Andhra Pradesh. The order comprises 24 units of Suzlon's S88 – 2.1 MW wind turbines which will be set-up in the Gandikota region, Kadapa district, Andhra Pradesh. This order marks NALCO's entry into the wind energy sector, with the project scheduled for completion and commissioning by January 2012. The power generated will be sold to the state electricity grid. NALCO plans to register the project under the clean development mechanism (CDM).

www.orissadiary.com, 26 June 2011



INDIAN SOLAR DEALS IN THE LAST 18 MONTHS

Target	Deal Value ($ mn)
Shalivahana Green Energy	15.5
Kiran Energy Solar Power	30.0
Sunborne Energy Technologies	18.5
Applied Solar Technologies India	7.0
Indosolar	1.2
Soham Renewable Energy	19.3
Azure Power India	10.0

SOURCE: VCCEDGE

India a hotspot for solar venture capitalists

Solar energy, a growing favourite with venture capitalists worldwide, has another favourite now – India. Private equity firms putting their money on solar power equipment components such as modules, cells and waters are now looking at the country, moving away from advanced markets, say industry executives and analysts. As much as Rs 450 crore has flowed into India's solar energy sector in the past 18 months, according to the estimates by venture capitalism blog VC circle. In 2011, the sector has received more than Rs 200 crore. The World Bank's private sector lending arm, the International Finance Corporation (IFC) is also eyeing India's solar sector.

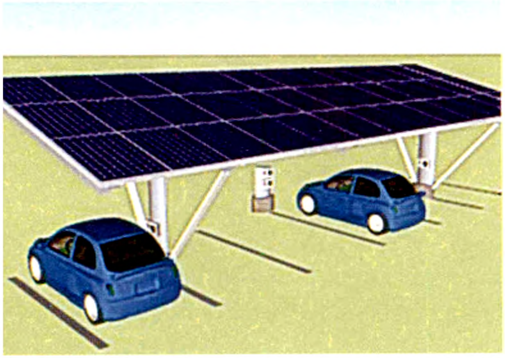
www.hindustantimes.com, 22 June 2011

New solar charge for electric cars

Motorists with electric cars will be able to 'fill-up' directly from the sun when Britain's first public solar-powered charger opens in London in July. Use The Sun, which is managing the eTap project in Rainham and carrying out the installation, says motorists will pay GBP 1 to plug in, and then 63 pence an hour. A three-hour charge will cost a motorist about GBP 2.90 and deliver a range of about 47 miles. A motorist driving a similar-sized traditional car would spend about GBP 5.90 to travel the same distance. Six cars can park underneath each booth at a time and draw current directly from the sun, into their cars' batteries. When the sun is not shining, the charger draws power from the National Grid. The facility being installed at the Centre for Engineering and Manufacturing Excellence looks like a cross between a futuristic domestic carport and a giant sun canopy. The 'solar garage' contains hundreds of photosensitive cells.

When it is not charging up cars the eTap will produce enough electricity to power more than 100 40-watt light bulbs or 23 laptops. The cost of installing and buying a six-bay eTap is about GBP 55,000 but, it is claimed that it would cover its cost in 10 years.

www.usethesun.co.uk, 24 June 2011.



Less expensive solar cells based on rare earth elements

NUtech Ventures and Rare Earth Solar have announced an exclusive license agreement involving technology that replaces the typical semiconductor materials now used in solar cells with rare earth elements. NUtech Ventures is a nonprofit organisation that forms partnerships between University of Nebraska researchers and the private sector. University of Nebraska-Lincoln assistant professor of chemistry Chin Li "Barry" Cheung and his then-doctoral student Joseph Brewer developed the patent-pending technology. Rare earth elements are used to make many high-tech goods as they are more readily available and less expensive than competing commercial materials such as tellurium, indium, and gallium.

Allen Kruse, the co-founder and CEO of Rare Earth Solar, says "This is not a spin off of what currently exists; it truly is a completely new material system. We have been able to reproduce multiple cells at various sizes and are now working on the basic engineering to scale up to a full size module, essentially getting voltage and current where we want it, to meet the largest industry demand." The company will be selling a glass-on-glass thin film photovoltaic module. Kruse says that the company's unique process utilising rare earth elements and turnkey equipment will produce panels that are more durable and cost-effective than many thin film panels currently available in the market.

www.nutechventures.org, 26 June 2011

Record efficiencies for a single junction solar cell

Alta Devices achieved an efficiency of 27.6 per cent late last year and, more recently, 28.2 per cent with GaAs-based single junction solar cells. The National Renewable Energy Laboratory (NREL), USA has verified both results. To put the numbers into perspective, the previous highest demonstrated efficiency was 26.4 per cent, and the theoretical maximum solar cell efficiency limit – or Shockley-Queisser Limit – for a single junction device has been shown to be 33.5 per cent.

"Up until now it was understood that to increase the current from our best solar materials, we had to find ways to get the material to absorb more light," said Alta co-founder Eli Yablonovitch, director of the NSF Centre for Energy Efficient Electronics Science and professor at the University of California at Berkeley. "But, the voltage is a different story. It was not recognised that to maximise the voltage, we needed the material to generate more photons inside the solar cell. Counter-intuitively, efficient light emission is the key for these high efficiencies."

Alta has been energised by the Department of Energy's goal of USD 1 per installed watt and the company says that maximising efficiency and, perhaps more importantly, energy density is essential to optimise the production economics of solar PV. The company is developing the processes and capabilities to manufacture GaAs solar cells, and the products they become embedded within, at its pilot manufacturing facility in Sunnyvale, California.

www.ieee-pvsc.org, 23 June 2011

MIT's 'Artificial Leaf' for solar water splitting moves forward

An important step toward realising an inexpensive and simple 'artificial leaf' for harnessing sunlight through water splitting has been accomplished by two separate research teams at Massachusetts Institute of Technology (MIT), USA.

The teams produced devices that combine a standard silicon solar cell with a catalyst developed three years ago by professor Daniel Nocera. Eventually Nocera wants to produce a low-cost device for use where electricity is unavailable or unreliable. It would consist of a glass container and a solar cell with catalysts on each side attached to a divider separating the container into two sections. When exposed to sun, the electrified catalysts produce bubbles of hydrogen on one side and oxygen on the other, which could be collected and later recombined through a fuel cell or other device to generate electricity when needed.

The next step to producing a usable artificial leaf, explains Nocera, will be to integrate the final ingredient: an additional catalyst to produce the hydrogen atoms. The current devices dissociated hydrogen atoms into the solution as loose protons and electrons. If a catalyst could produce fully formed hydrogen molecules (H2), the molecules could be used to generate electricity or to make fuel for vehicles.

Nocera encouraged two different teams to work on the project so that each could bring their special expertise to addressing the problem. Bringing together silicon solar cells with the cobalt phosphate (Co-Pi) catalyst material was no trivial matter because water splitting by the catalyst creates a "very aggressive" chemical environment that tends to rapidly degrade the silicon, destroying the device as it operates.

To overcome this, both teams found ways to protect the silicon surface while allowing it to receive the incoming sunlight and to interact with the catalyst. Both teams had to add an extra power source to the system, because the voltage produced by a single-junction silicon cell is not high enough to use for powering the water-splitting catalyst. In later versions, two or three silicon solar cells will be used in series to provide the needed voltage without the need for any extra power source, the researchers say. Although the two approaches to bonding the catalyst with a silicon cell appear to produce functioning, stable devices, so far they have only been tested over a few days. The researchers expect that they will be stable for long periods, but accelerated aging tests will need to be performed to confirm this.

http://web.mit.edu, 10 June 2011

Managed Document Services
RICOH
100% Solar and Wind Powered Billboard

Ricoh launches 100 per cent sustainable 'eco-board' in London

Ricoh Europe unveiled Europe's first 'eco-board'; a billboard powered 100 per cent by wind and solar power. The Ricoh eco-board is the first of its kind in Europe in having dual natural sources of power so that it illuminates only when sufficient power is collected. The European eco-board joins Ricoh's solar powered billboard launched in Times Square, New York last year.

www.ricoh-europe.com, 28 June 2011

Biofuels from algae, wood chips are approved for use by passenger airlines

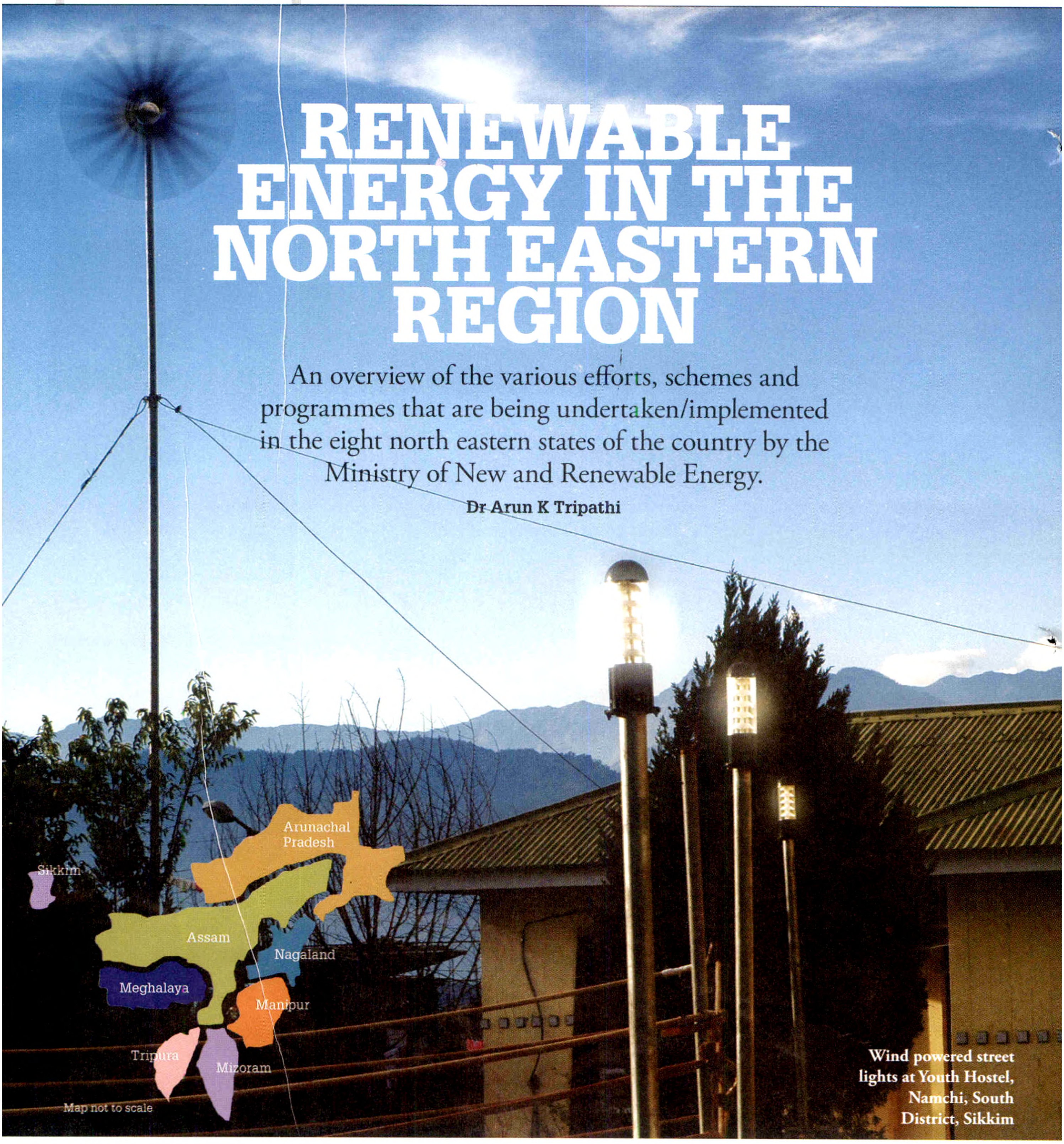
Airlines won the backing of a US-based technical-standards group to power their planes with a blend of traditional fuel and biofuel from inedible plants, the Air Transport Association (ATA) said. Fuel processed from organic waste or non-food materials, such as algae or wood chips, may comprise as much as 50 per cent of the total fuel burned to power passenger flights, said ATA spokesperson Steve Lott and a Boeing Co. (BA) official. The decision to amend jet fuel specifications to include fuels from bio-derived sources "is a tremendous accomplishment for aviation and the result of tremendous collaboration across the entire industry," said Boeing Vice President of Environment and Aviation Policy Billy Glover.

www.bloomberg.com, 13 June 2011

RENEWABLE ENERGY IN THE NORTH EASTERN REGION

An overview of the various efforts, schemes and programmes that are being undertaken/implemented in the eight north eastern states of the country by the Ministry of New and Renewable Energy.

Dr Arun K Tripathi



Wind powered street lights at Youth Hostel, Namchi, South District, Sikkim

The eight states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura together comprise the north eastern states of India. Each state has its own unique geography, people and culture and yet they are bound together by their distinct location within the country. Also, each of the eight states is a 'border state', that shares boundaries with another country.

The north eastern region (NER) as a whole has a tremendous potential for harnessing renewable energy

(RE) - be it solar, wind, geothermal, biogass or small hydro. Renewable energy systems and devices can play an important role in meeting power and energy requirements in remote areas of the region. To realise this potential special attention is being given to the development of the eight states in the region through a separate budget allocation under various RE programmes. For the year 2010-11 the Ministry of New and Renewable Energy (MNRE) has allocated 10 per cent of the budgetary support for the deployment of biogas plants, solar thermal systems, solar photovoltaic (PV) systems, remote village electrification (RVE), small hydro projects (SHPs), wind energy systems, village energy security projects and energy parks.

Biogas Programme

The National Biogas and Manure Management Programme (NBMMP) is being implemented in the NER through state government departments/state nodal agencies (SNA). The Khadi and Village Industries Commission (KVIC) also implements the programme in Arunachal Pradesh, Assam, Meghalaya, Nagaland, Sikkim and Tripura. The statewise achievements of family type biogas plants in the NER up to May 2011 is given in Table 1. The Biogas Development and Training Centre for the NER located at Indian Institute of Technology (IIT) Guwahati, Assam provides the technical and training support for the programme.

Solar Photovoltaics

During 2010-11, Central Electronics Limited a public sector company was sanctioned 27 projects for installation of stand-alone solar PV power projects aggregating to 935 kWp capacity. The installations were to be done in Sashastra Seema Bal (SSB) and educational institutions in Arunachal Pradesh (11 projects of total 320 kWp capacity), Assam (6 projects of total 500 kWp capacity) and Sikkim (10 projects of total 115 kWp capacity). In Manipur, 4 stand-alone solar PV power projects of 100 kWp capacity were sanctioned for installation at hospitals, the jail and the State Training Academy. While in Meghalaya 3,350 solar home lights (SHLs) and 171 stand-alone solar PV power projects of total 560 kWp capacity were sanctioned for installation at various institutions. For installation in hospitals and charitable institutions in Mizoram, 7 stand-alone solar PV power projects of totaling 121 kWp capacity were sanctioned. In Nagaland, 10 stand-alone solar PV power plants were sanctioned for installation in government institutions. SPS power plants of 168 kWp capacity were also sanctioned for installation in Tripura at different educational institutions.

Table 1: Family type biogas plants achievements in the north eastern region (NER)

State	Estimated Potential (Number of plants)	Cumulative physical achievements up to May 2011 (Number of plants)
Arunachal Pradesh	7500	3132
Assam	307000	88324
Manipur	38000	2128
Meghalaya	24000	7936
Mizoram	5000	3920
Nagaland	6700	5324
Sikkim	7300	7691
Tripura	28000	2882
Total	**4,23,500**	**1,21,337**

A 10 kW wind-solar hybrid power plant at Parsuram Kund Tezu, Lohit District, Arunachal Pradesh

Solar Cities

Six cities in the NER - Agartala, Guwahati, Jorhat, Imphal, Kohima and Itanagar are being developed as Solar Cities under the scheme. Sanctions have been issued and their master plans are under preparation. Solar City Cells have been created in the municipalities of these cities. Stakeholders committees have also been formed to ensure public participation.

The 350 kW mini hydro project at Gelnal Village, Senapati District, Manipur

Special Area Demonstration Project

Under the Special Area Demonstration Project Scheme, for the north eastern states, the Ministry provides full support up to Rs 1 crore for world heritage sites and Raj Bhawans; Rs 50 lakhs for state assemblies; Rs 25 lakhs for secretariats; Rs 1 crore for State Level Energy Parks; 90 per cent support up to Rs 10 lakhs for collectorates, national parks, zoological gardens and science museums; and 50 per cent support up to Rs 25 lakhs for heritage institutions and religious locations with devotees visit of 10 lakhs or more annually.

Under the Scheme, the Ministry has so far supported 7 Energy Parks in Arunachal Pradesh, 23 in Assam, 10 in Manipur, 8 in Meghalaya, 8 in Mizoram, 7 in Nagaland, 8 in Sikkim and 10 in Tripura. It has also supported projects at the Raj Bhawans of Arunachal Pradesh, Manipur, Meghalaya and Tripura and the State Assembly of Sikkim.

Remote Village Electrification

The villages in the NER continue to receive special attention under the RVE programme as many of these are most suitable for electrification through stand-alone RE devices. A number of villages in these states are too remote to be electrified through grid extension. A portion of the budget of the RVE programme is earmarked for these 8 States. So far, 3092 remote villages and hamlets have been provided RE based systems. The status of the RVE programme in the North East States is given in the Table 2.

Table 2. Remote village electrification (RVE) programme in the North Eastern States

State	Villages sanctioned	Villages completed	Hamlets sanctioned	Hamlets completed
Arunachal Pradesh	297	297	1	0
Assam	2157	1688	0	0
Manipur	237	191	3	0
Meghalaya	163	97	0	0
Mizoram	20	20	0	0
Nagaland	11	11	0	0
Sikkim	0	0	13	13
Tripura	62	60	944	715
Total	2947	2364	961	728

Small Hydro Power

The North Eastern States have a good potential to develop SHP projects. Among the 8 states, Arunachal Pradesh has the highest potential followed by Sikkim, Meghalaya and Mizoram. MNRE has been giving special emphasis for the development of SHP projects in the NER and a higher level of financial support has been provided under SHP schemes. So far, 164 SHP projects aggregating to 275.65 MW have been set up in the north eastern states and another 45 projects aggregating to 68.06 MW are under implementation (Table 3). Last year, two new projects were sanctioned in Arunachal Pradesh and Sikkim. The Ministry is implementing a project on electrification/ illumination of 1058 border villages in Arunachal Pradesh through completion of ongoing and installation of new SHP projects and solar PV systems. Till date, 714 villages including 523 villages from solar PV HLS and 191 villages from small/micro hydel projects have been illuminated/ electrified. A detailed exercise was undertaken to assess the renovation and modernisation requirement of existing SHP projects in Arunachal Pradesh, based on which, the Ministry has approved the renovation of 15 SHP projects in the State.

Table 3. Small hydro power: State-wise potential and achievement in the North Eastern Region

State	Sites (Nos.)	Potential (MW)	Achievement (MW)
Arunachal Pradesh	550	1333	78.80
Assam	119	238	27.11
Manipur	114	109	5.45
Meghalaya	101	229	31.03
Mizoram	75	166	36.47
Nagaland	99	188	28.67
Sikkim	91	265	52.11
Tripura	13	46	16.01

Looking Forward

Sincere efforts from the states and focussed attention from the Ministry is assisting the North Eastern Region to slowly but surely make its mark on the renewable energy map of India. The data showing the deployment of various solar applications in the remote villages of the region and exploitation of other RE sources are hallmark of relentless effort made by the Ministry. ✪

The author is Director, Ministry of New and Renewable Energy, New Delhi. aktripathi@nic.in

Ministry of New and Renewable Energy

"PRAKRITIK URJA PURASKAR YOJNA"

Ministry of New and Renewable Energy, Government of India, is operating 'Prakritik Urja Puraskar Yojna' to encourage original book writing in Hindi or translation of books in Hindi in the field of New and Renewable Sources of Energy. Under the scheme, there is a provision to award a first prize of Rs. 50,000/-, a second prize of Rs. 30,000/- and a third prize of Rs. 20,000/- every year. All authors, whether Government employees or Non-Governmental persons, can participate in the scheme. Entries are invited for the award for the calendar year 2010. The last date of receipt of entries is August 31st, 2011. Entries will be accepted in prescribed proforma only.

For further details, please contact
Dy. Director (OL),
Ministry of New and Renewable Energy
Block – 14, CGO Complex, Lodhi Road,
New Delhi – 110 003
Tel. +91 11 24362356
or visit this Ministry's
website www.mnre.gov.in

hnology Demonstration Project
Solar Thermal Air Conditioning System
at Solar Energy Centre, Gurgaon
Inaugurated by
Dr. Farooq Abdullah
nion Minister of New and Renewable Energ
In the presence of
Shri Sushilkumar Shinde
Hon'ble Union Minister of Power
gned, Built, Installed and Commissioned by
Solar Energy Centre
and
Thermax Limited

High efficiency solar thermal cooling system

was inaugurated at Solar Energy Centre, Gurgaon

Dr Farooq Abdullah, Minister for New and Renewable Energy, inaugurated the high efficiency solar thermal cooling system at the Solar Energy Centre of the Ministry in Gurgaon, Haryana on 1 July 2011. Shri Sushil Kumar Shinde, Minister of Power, was also present on the occasion.

The new 100 kW solar air conditioning system works at 30 per cent higher efficiency than the current available systems and has several unique features. It is based on the new triple effect absorption cooling technology. The system has indigenously built medium temperature high efficiency parabolic troughs for collection of solar energy and effective solar thermal energy storage in the form of phase change materials.

The present system will cater to air conditioning needs of 13 rooms of the Solar Energy Centre. To achieve this, 288 sq m of solar collector area has been installed which generates nearly 60 kW of 210°C pressurised hot water. This heat is used in a vapour absorption machine to generate 7°C chilled water, which in turn circulates through the fan coil unit installed in the thirteen rooms. The major attraction of this system is that the hottest days have the greatest need for cooling and simultaneously, offer the maximum possible solar energy gain.

The system has been developed in joint collaboration by Solar Energy Centre with M/s Thermax Limited, Pune and is expected to meet the growing demand for air conditioning in India in a highly efficient and cost effective way through the use of direct solar energy. ✪

Workshop on
Solar Thermal Systems in Imphal

On 1 July 2011 a one day workshop on solar thermal systems was organised by Manipur Renewable Energy Development Agency (MANIREDA) at the conference hall of Hotel Classic, Imphal. Under a scheme supported by the Ministry of New and Renewable Energy (MNRE), MANIREDA will be supplying solar thermal systems or 'solar water heaters' to consumers in Manipur at a subsidised rate. The purpose of the workshop was to familiarise the consumers who have applied for the said systems as well as the general public on the working and benefits of the system in particular and solar technology in general.

In his address the chief guest Shri L Jayentakumar, Minister for Health and Family Welfare congratulated MANIREDA on doing "one of the best jobs", stressing that, "the right to life includes the right to power". He also emphasised that this was just the beginning of the use of renewable energy in the state.

The president of the inaugural session was Shri H Imocha Singh, Commissioner (Science & Technology) cum Member Secretary, MANIREDA. Present as guests of honour were Shri Anand Narwani, Senior Scientist MNRE, Shri Prem Chand, Under Secretary, MNRE, Shri DR Das, Director, MNRE (NE Region) and Shri RK Nimai, Commissioner (Art & Culture) and Secretary to the Governor of Manipur. As per the Manipuri tradition, a shawl was presented to all the dignitaries as a token of respect and appreciation.

In his welcome cum introduction talk Shri L Manglem Singh, Director MANIREDA highlighted the present role of the organisation in promoting alternative means of energy in the state as well as outlined the future plans especially with respect to the solar thermal systems.

In the technical session, T Ananth, CEO Nutech Solar Systems Pvt. Ltd., Bangalore gave a presentation on the working, installation, maintenance and benefits of a solar water heating system.

The workshop was attended by about 215 participants and ended with a lively interaction - with the delegates on one hand and the representatives from MNRE, officials of MANIREDA and Mr Ananth on the other. ✪

Smt. Meira Kumar
Hon'ble Speaker, Lok Sabha
In the presence of
Dr. Farooq Abdullah
Hon'ble Union Minister for New & Renewable Energy, Govt of India
Tuesday, the 9th day of August 2011

Lok Sabha Speaker

Inaugurates Solar Energy Systems at Parliament House Complex

The Parliament House took a major step towards sustainable energy when Lok Sabha Speaker Smt Meira Kumar inaugurated a 80 kWp solar photovoltaic (PV) power plant and a 2000 lt per day solar water heater system (SWHS) at the Parliament House Complex in New Delhi on 9 August 2011. The Minister of New and Renewable Energy, Dr Farooq Abdullah was also present on the occasion. The new systems are part of the demonstration of renewable energy systems at the Parliament House complex under the 'Special Area Development Project' of the Ministry of New and Renewable Energy (MNRE).

The 80 kWp solar PV rooftop plant installed at a cost of Rs 1,19,75,529 will help in reduction in the use of conventional electricity and diesel power and reduce dependence on conventional grid power. The SWHS will supply 2000 lt per day of hot water to Parliament House annexe canteen. It is expected to save 6,000 kg of LPG per year. 20 solar street lighting systems and a 500 kg per day kitchen waste based biogas plant are also under process of installation as part of the project.

Speaking on the occasion Smt Meira Kumar expressed her appreciation of the concerted efforts of the MNRE and the alacrity with which Dr Abdullah responded to her remarks made in Parliament on 11 December 2009, with respect to the incorporation of solar and other renewable energy systems in the Parliament House complex. She further mentioned that these initiatives would go a long way not only in making the Parliament House complex energy efficient but also in setting examples for other buildings and complexes. She further said that India has a vast potential for use of solar energy in meeting the energy needs of the people. She appreciated the progress made under the Jawaharlal Nehru National Solar Mission (JNNSM) and said that the Mission will help in providing energy access in remote and inaccessible areas.

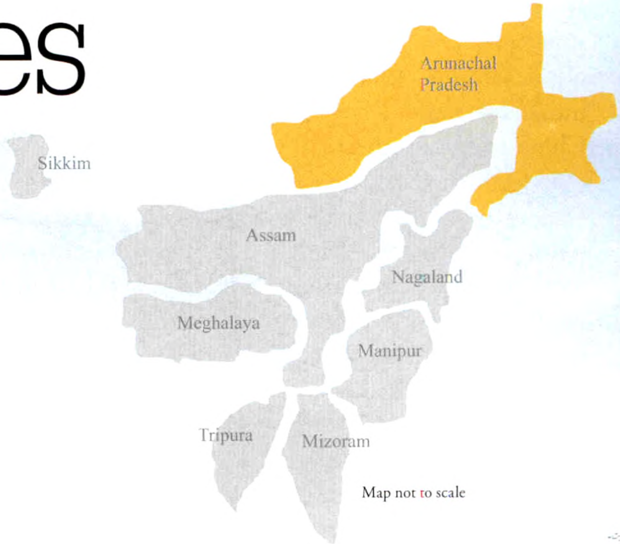
Dr Farooq Abdullah thanked the Speaker for taking the initiative and providing an opportunity for his ministry to demonstrate the use and benefits of renewable energy systems at Parliament House complex. He mentioned that the role of new and renewable energy has been assuming increasing significance. In view of growing emphasis on the country's energy security and to check global warming besides meeting energy needs in an environmentally benign manner, renewable energy was being promoted. He also informed the Speaker that renewable energy systems had been installed in over 50 places of national, historical and religious importance including 21 Raj Bhavans; Dargah Ajmer Sheriff; Shri Mata Vaishno Devi Shrine Board; Saifi Villa at Dandi; BSF Camp at Indo-Pak Border at Atari near Amritsar; Golden Temple, Amritsar; Chittorgarh fort, Badrinath and Kedarnath dhams; Jantar Mantar and Safdarjung Tomb, New Delhi etc.

Arunachal Pradesh

Illuminating Border Villages

The Prime Minister announced a special package for illumination/electrification of villages located in the border districts through a mix of grid connected/ decentralised systems on 31 January 2008.

Marki Loya and **Timi Muri**



CALCUTTA UNIVERSITY

A 2X15 kW project under Component-III of the Prime Minister's Package, Arunachal Pradesh

Arunachal Pradesh is also called the 'land of the rising sun' and the 'land of dawn-lit mountains', it is the largest state amongst the eight north eastern states, with a total area of 83,743 sq km. It stretches from the snow capped mountains in the north to the plains of the Brahmaputra valley in Assam in the south. A land of lush green forests, deep river valleys and beautiful plateaus, the people of Arunachal Pradesh are simple, peace-loving and hospitable with a glorious heritage of art, culture and colourful festivals. The state has a long international border with Bhutan in the west (160 km), China in the north (1030 km) and Myanmar in the east (440 km). Nagaland and Assam lie in the south.

Due to the different altitudes, the climate varies from the south to the north. While it is hot and humid along the foothills bordering Assam, it is cold along the international border in the north where the mountains are high and lofty and are permanently snowcapped even during summer. Numerous perennial rivers and rivulets originate from these mountains.

The State Nodal Agency

The Arunachal Pradesh Energy Development Agency (APEDA) was created out of the Rural Works Department (RWD) in the year 1996. It's entity till then was an Energy

A beneficiary of solar home lighting system (SHLS) in Barafu village, Anjaw District, Arunachal Pradesh

Prime Minister's Package

The Hon'ble Prime Minister of India, Dr Manmohan Singh on his maiden visit to the state of Arunachal Pradesh on 31 January 2008 announced a package for illumination/ electrification of households/villages located in the international border districts of Arunachal Pradesh through a mix of grid connected/decentralised mini/micro/small hydro power projects and through solar photovoltaic (PV) systems. The total package announced was for an amount of Rs 550 crores. To accomplish this announcement, three departments of the State are involved namely APEDA, Department. of Hydro Power Development and Department of Power.

The following work components are assigned to APEDA under the Package:

Component-I: To illuminate 546 border villages through solar home lighting systems (SHLS) at an estimated cost of Rs 11.03 crores.

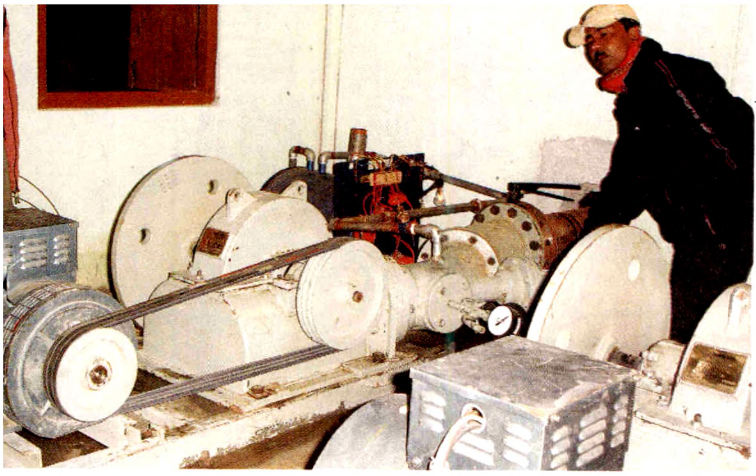
Component-II: To electrify 191 villages through setting up of 67 micro and mini hydel projects of capacities ranging from 10 kW to 200 kW at a sanctioned cost of Rs 43.67 crores.

Component-III: To complete 31 languishing mirco hydel projects ranging from 5 kW to 40 kW (as resource-gap funding) at a cost of Rs 2.74 crores.

The Department of Hydro Power Development is engaged in the following works under the same Package:

1. To complete 42, incomplete on-going projects with capacity addition of 47.28 MW at an additional cost of Rs 169.11 crores to benefit 670 villages.
2. To complete 4 projects (2 on-going and 2 new) to give capacity addition of 17.03 MW to benefit 140 villages at an additional cost of Rs 105.31 lakhs.
3. To complete 14 on-going projects with a capacity addition of 6.62 MW at an additional cost of Rs 16.73 crores.
4. To complete 36 new projects to provide capacity addition of 10.62 MW for electrification of 419 border villages at a cost of Rs 146.94 crores.

The Department of Power is assigned to construct connectivity lines from the hydel projects constructed by the Department of Hydro Power Development to evacuate power to the targeted villages.



2x15 kW turgo impulse turbine couple to alternator, Norbuling Micro hydel station, Arunachal Pradesh

> **The State Government has engaged the North East Development Financial Corporation (NEDFC) for third party monitoring to evaluate the quality and quantity of all projects.**

Wing in the RWD. It is now a state government agency of the Government of Arunachal Pradesh and is registered under the Societies Registration Act, 1860. APEDA is the State Nodal Agency (SNA) for all the programmes and schemes connected with renewable and non conventional energy sources; all such programmes and schemes sponsored by the Ministry of New and Renewable Energy (MNRE) are either executed or routed through it.

Implementation of the PM's Package by APEDA

Under Component-I, a total of 546 border villages, where the households were less than 30 in number and which had no perennial source of water for construction of hydel projects, were to be illuminated through SHLS of Model-II with 37 W module as per the MNRE specification under the Prime Minister's Package. Out of 546 targeted villages, 523 villages were covered by installing SHLS in 5852 households (Table 1). The villages so illuminated are extremely remote and they are approachable by porter tracks only. Some of the villages take even two to three days walk to reach.

Table 1. District-wise achievement under Component-I of Prime Minister's Package

Name of district	Number of villages illuminated	Number of households covered
Anjaw	197	1930
Changlang	5	169
Kurung Kumey	79	941
Dibang Valley	52	277
Tawang	4	38
West Kameng	11	155
West Siang	29	440
Upper Siang	8	112
East Kameng	77	1094
Upper Subansiri	61	696
Total	523	5852

Under Component-II, 191 villages, where there were a perennial source of water and which had more than 30 households, were to be electrified by setting up of 67 mini and micro hydel projects of capacity ranging from 10 kW to 200 kW (Table 2). The works in these projects are going on in full swing and they are targeted to be completed by March 2012. All the sites are very remote and the construction materials are required to be carted manually. In some of the project sites the cartage cost of a bag of cement is more than the cost of the cement.

Table 2. District-wise targets under Component-II of Prime Minister's Package

Name of district	Number of projects	Number of villages
Tawang	10	31
West Kameng	5	25
East Kameng	11	16
Kurung Kumey	11	46
Upper Subansiri	7	16
West Siang	8	24
Upper Siang	3	5
Dibang Valley	5	10
Anjaw	6	16
Tirap	1	2
Total	67	191

Under Component-III, 31 micro hydel projects which were languishing over the years since the year 2003-04 due to want of funds, could be completed with an allocation of Rs 2.74 crore from the PM's Package and more than 40 villages have benefited from these projects.

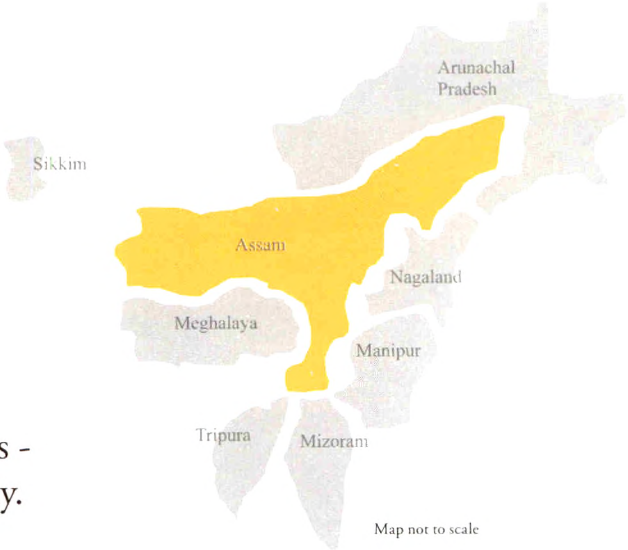
The State Government has engaged the North East Development Financial Corporation (NEDFC) for third party monitoring of the projects to evaluate and ensure quality and quantity of the work undertaken and also to evaluate the impact the Programme has on the people.

The authors are Director and Information and Publicity Officer, Arunachal Pradesh Energy Development Agency (APEDA), Itanagar, Arunachal Pradesh, director@apeda.co.in

Assam
RE Energising Rural Assam

After using the solar home lights (SHL) systems, there is a sea change within the rural communities - use of kerosene wick lamps has been cut drastically.

Dr Satyendra Kumar Choudhury and Mrinal Krishna Chaudhury



Assam is the sentinel of north east India and the gateway to seven north eastern states. The State is surrounded by Bhutan and Arunachal Pradesh in the north, Manipur, Nagaland and Arunachal Pradesh in the east and Meghalaya, Tripura and Mizoram in the south. It is endowed with a bounty of serene landscape, plenty of natural resources and the lush greenery of the tea gardens and wild life sanctuaries. The mighty Brahmaputra flows through the entire length of the state with a number of tributaries joining it from the Himalayan range in the north. With varying topography, the entire State has plenty of locations that usually remain cut off from the urban pockets.

Solar panel of a solar home lighting (SHL) system perched on a bamboo pole outside a house in Lakshipathar village, Golaghat District, Assam.

Many places in the State which are now inhabited but sparsely populated, lie in the stabilised sandbars called 'chars' which are formed in the middle of the river, like a typical island, by the changing course of the river or due to siltation. These locations are very difficult to connect to the grid as the river and thin population, make it commercially unviable.

The State Nodal Agency

The Assam Energy Development Agency (AEDA) was earlier a part of Assam Science, Technology and Environment Council (ASTEC). ASTEC was constituted in 1986-87 as an autonomous council under the Department of Science, Technology and Environment, Government of Assam for implementation of some of the major programmes in the sectors of science and technology, remote sensing, energy (non conventional and renewable sources) and environment. AEDA was formally constituted in July 2002 under the Societies Registration Act (1860) to act independently as the nodal agency for implementing programmes related to new and renewable sources of energy under the Ministry of New and Renewable Energy (MNRE) (Table 1).

Development of Renewable Energy in the State

Apart from implementing different renewable energy programmes, AEDA is also implementing the remote village electrification (RVE) programme in the State. The MNRE initiative to meet the basic lighting demand of isolated villages throughout the NE region has found immense popularity particularly in Assam. After analysing the dimensions and merits of different alternatives of decentralised power, the ultimate source, which has been widely accepted by the rural masses, is the solar photovoltaic (PV) lighting system.

In Assam, a list of 2,139 villages, identified to be difficult to cater to through the conventional power grid, was prepared by the government agencies. It was suggested that these villages be provided with power from renewable resources

Table 1. AEDA Implementing Programmes under MNRE

Project/ Programme	Installation so far
Solar PV - village electrification	771 villages
Solar PV- general programme	3,566 households
Solar hot water systems (SHWS)	15 locations
Micro hydel project	2 locations
Wind monitoring mast	10 locations
Institutional Energy Parks	20 locations
State Level Energy Park	1 locations
Solar Mini Power Plants	5 locations

> **Apart from providing lighting facility to the rural households the RVE programme has contributed immensely towards a sustainable and greener environment.**

Community lighting system installed at a temple in Hatukagaon village, Karbi Anglong District, Assam

Solar street light under RVE programme in Lakshipathar village, Golaghat District, Assam.

P 35,431

A school student studying in the light of a SHLS in Lakshipathar village, Golaghat District, Assam.

Solar light installed at Hemeribey village, Karbi Anglong District, Assam

particularly through solar PV lighting facilities to meet the lighting demand of the individual households as well as the community. MNRE extended 90 per cent financial support to take this Programme to the far corners of the State whereas the balance amount was met by the individual beneficiaries and the State Government. Three different agencies, AEDA which is the State Nodal Agency (SNA), the Renewable Energy Wing of the Assam State Electricity Board and the Social Forestry Division of the State Forest Department have been instrumental in the execution of the project.

AEDA is providing solar lighting facilities in 920 villages covering 19 districts in the State. After initial survey of the villages, the total number of households to be provided with the facility is identified and solar home lighting (SHL) systems comprising of a solar PV module of 37 Wp capacity, 2 luminaries with 9 W CFL lamps, a 12 V 40 Ah tubular cell battery and charge controller along with cables and structures are installed. These systems are designed to provide lighting for 4 to 5 hours each night with 3 days autonomy.

Apart from providing the lighting facility to the rural houses, the village is also provided with such facilities for lighting of temples, mosques, churches, clubs and the like. Solar street lights are often provided at street corners, market places etc. The common facility is looked after and managed by a village energy committee (VEC) formed by the beneficiaries of the particular village. Two rural youth among the village are trained by the equipment suppliers to look after the day to day maintenance. If the trained youth are not able to address a problem, it is reported to the supplier since the systems are covered under 5 years comprehensive maintenance contracts. Having such a facility in a remote unelectrified household is really a boon to the rural community.

Measuring the Success

Earlier, most villages used kerosene wick lamps as a source of lighting. After using the SHL systems, there is a sea change within the rural community. Use of kerosene oil has drastically come down and the environment inside the houses has become clean due to reduction of smoke and subsequent blackening of the walls due to the wick lamps.

Computing reduction of kerosene usage by 30,000 rural households that have been provided solar lighting facilities by AEDA, yield startling results. In case there is a reduction of 4 lt of kerosene oil per family per month, for 30,000 families, it totals to 1.2 lakh lt per month and 14.4 lakh lt of kerosene saving annually. Interpreted in monitory terms this would result in an annual saving of about Rs. 2.3 crores towards kerosene consumption. Similarly, one can quantify the amount of carbon reduction, which has been made using the solar lighting facility. One has to appreciate that apart from providing lighting facility to the rural households the RVE programme has contributed immensely towards a sustainable and greener environment. Today mobile phones have penetrated every nook and corner of the country. There is immense scope for solar mobile charging facility in places where no power is available. In Assam, many people get their mobile sets charged from the battery provided along with the SHL Systems using a small charging device.

Endnote

In the context of present energy scenario AEDA through different renewable energy schemes and programmes of MNRE is committed to meet the RE requirements and demands of the State. ✪

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Mizoram
Exploring Wind and Hydro

Mizoram has a great potential for wind as also micro and small hydro power, however, the exact potential is waiting to be explored by the experts.

David C Zahmuaka and Thantluanga

The 25 kWp solar PV power plant at Kulikawn Civil Hospital, Aizawl, Mizoram

Mizoram nestled in the picturesque and gentle rolling hills in the southern most tip of the north eastern region (NER) is a small State with 22 towns and as many as 817 census villages. Presently the State is on course for all round development with major thrust on growth in the rural areas.

One of the major hurdles in the development process of the State is the lack of access to electricity in urban as well as in rural areas. This is especially acute in the rural areas, perpetrating a passive energy crisis, where productive applications are constrained due to lack of effective access to energy, even if there could be affordability. Access to affordability is therefore a key element for poverty reduction in rural Mizoram.

The State Nodal Agency

Zoram Energy Development Agency (ZEDA) is an autonomous body established by the Government of Mizoram with its headquarters at Aizawl. ZEDA is registered as a society under the Societies Registration (Extension to Mizoram) Act, ZEDA had submitted proposals to C-WET, Chennai for eight locations for Wind Resource Assessment with a mast of 50 m height.

1976 (Mizoram Act No. 3 of 1977), having a governing body headed by the Minister of Power of the State. It also has a Managing Committee headed by the Secretary of Power and Electricity Department, Government of Mizoram. The Agency became operational in 1999, exclusively to undertake all programmes in the field of non-conventional and renewable energy (RE) sources. Apart from this, ZEDA is also the Nodal Agency, which interacts with the Ministry of New and Renewable Energy (MNRE), to implement the centrally funded and sponsored scheme, in the field.

ZEDA is fully committed to boost the use of non-conventional and RE sources through the following steps: ● intensification of awareness campaigns by undertaking demonstration programmes all over the state; ● utilisation of all promotional schemes offered by MNRE; ● installation and commissioning of solar power plants, wind hybrid power projects etc. in the state; ● publication of brochures, booklets and pamphlets giving details of various RE schemes and devices available, for the benefit of the public; ● allocation of funds and holding of 'popularisation/demonstration' campaigns for effective implementation of RE programmes; and ● collaboration with various governmental departments and non government organisations for popularisation of RE systems and applications.

The 25 kWp solar PV power plant at Thutak Nunpui Tute (TNT) camp, Aizwal, Mizoram

Wind and Hydro Potential

Mizoram has a great potential of wind energy; however, the exact potential is yet to be explored by experts. The Centre for Wind Energy Technology (C-WET), Chennai, under MNRE was entrusted to conduct a wind resource assessment including wind mapping throughout the country with the cooperation from the respective State Nodal Agencies (SNAs) and accordingly, ZEDA has been extending all possible help to C-WET in Mizoram. C-Wet had done wind resource assessment at 5 locations - Sakawrhmuituai, Reiek, Hmuifang, Lunglei and Mamte with a mast of 25 m height. However, the result was found to be unsatisfactory. Again, C-WET selected two locations i.e. Chalfilh and Ngopa for the assessment with a mast of 50 m height which was found to be adequate. They completed the foundation work for these two locations in the year 2009 but erection is yet to be done. Early completion of wind monitoring stations at these locations is earnestly awaited. In addition to the above two locations ZEDA had submitted proposals to C-WET Chennai for eight more locations for wind resource assessment with a mast of 50 m height.

The State is also blessed with a good micro and small hydro electricity potential, which needs to be adequately harnessed. If the hydro potential is achieved, the State will be self sufficient in electricity and the SNA, ZEDA is taking every step possible to achieve this.

Development of RE in the State

ZEDA focuses on the promotion of solar thermal and solar photovoltaic (PV) systems/devices, hybrid projects (solar PV and wind) and rural energy activities, which include distribution of solar home lighting (SHL) systems in rural and semi urban areas. Other activities of ZEDA involve promotion and establishment of non-conventional energy parks, biomass gasifiers and installation of power plant at various places.

A draft of the RE policy for the state of Mizoram has already been formulated and tentatively approved by the state government after incorporating suggestions from the public. The policy is called 'The Mizoram Renewable Energy Policy 2003'. The policy designates ZEDA as the Nodal Agency for all RE activities in the State and further declares that ZEDA shall facilitate clearances for projects for producing electricity from non-conventional and RE sources on the lines of the facilitation provided by the Bureau of Industrial Promotion (BIP). The Agency is authorised to test for quality control of all the devices/equipment related to RE and as well as the energy saving devices to be used and sold in Mizoram.

Light in the Dark with Solar Energy

ZEDA had installed four 25 kWp solar PV power plants at various charitable homes and hospitals. Another 121 kWp is expected to be completed within this financial year. The charitable home, Thutak Nunpui Tute (TNT) is one of the largest in Asia. Although the Power Plant installed in TNT is only 25 kWp, it is of great help to the beneficiary as they save a lot in their electricity bills annually.

Apart from the above power plants, ZEDA had distributed 9073 solar lanterns, 6201 SHL systems and 40 solar power packs to the unelectrified and rural villages and NGO homes with the help of the fund received from MNRE and the State Government. Aizawl has been declared by MNRE as a Solar City. Master plan for the Solar City scheme had been submitted to the MNRE for approval. Mizoram has a great potential of solar energy, which needs to be exploited at a larger scale.

Suggestions for RE implementation

Almost all the power requirements of the State is met from the central sector, as the generation within Mizoram is negligible compared to the load requirement of the State. It is therefore necessary to explore and implement alternate energy projects, e.g. installation of solar power plants at various government buildings; provision of solar lanterns to the villagers; installation of mini grid connected SPV power plants at various villages; installation of grid connected SPV power plants in various parts of Mizoram; installation of solar PV street lighting system; and installation of SHL systems.

> **ZEDA had distributed 9073 solar lanterns, 6201 SHL systems and 40 solar power packs to the unelectrified and rural villages and NGO homes.**

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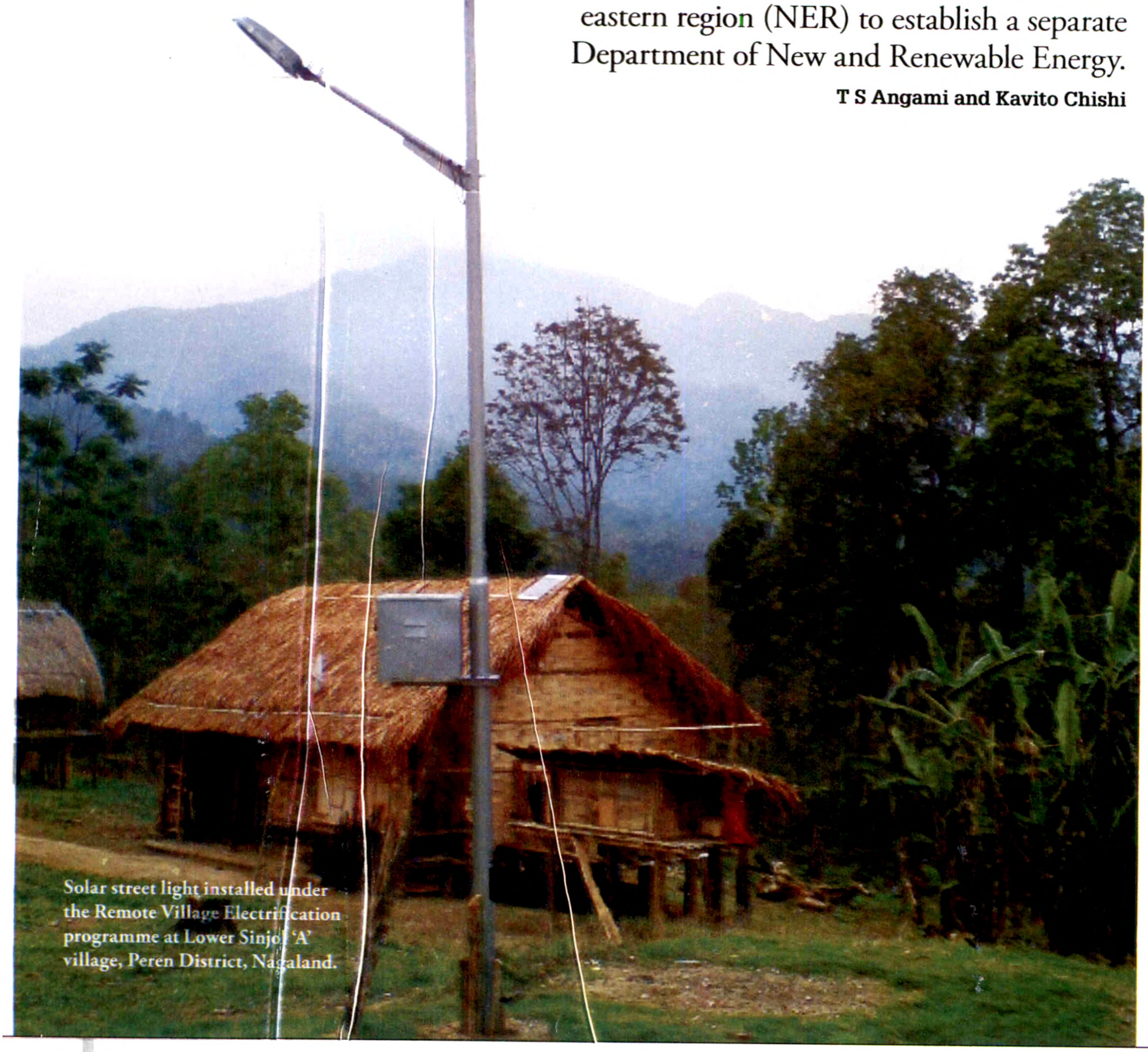
Nagaland Renewable Energy for the people

Underlining its commitment to green energy, Nagaland is the first state in the north eastern region (NER) to establish a separate Department of New and Renewable Energy.

T S Angami and Kavito Chishi



Solar street light installed under the Remote Village Electrification programme at Lower Sinjol 'A' village, Peren District, Nagaland.

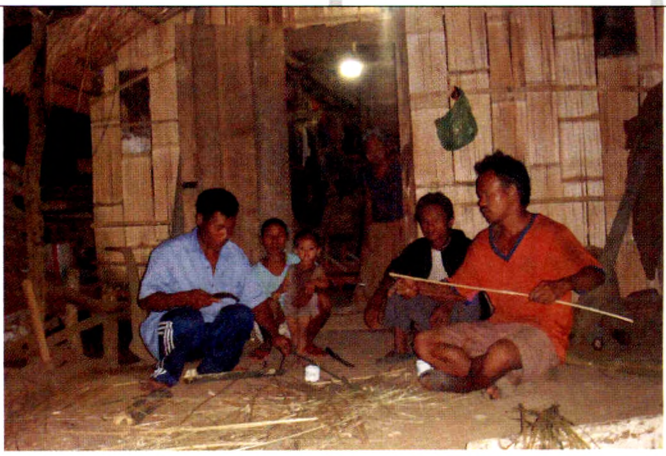
Nagaland, the 16th state of the Indian Union, was established on 1 December 1963. It is bound by Myanmar in the east, Arunachal in the north, Assam in the west and Manipur in the South. The state has an area of 16,579 sq km of mostly mountainous terrain except the areas bordering the Assam valley.

The State Nodal Agency

The Government of Nagaland recognising the importance of the green energy in view of global warming created a separate entity - the Department of New and Renewable Energy on 29 July 2009 to facilitate project development in the State in consonance with the various schemes and programmes of the Ministry of New and Renewable Energy (MNRE). The Department was created by merging the officers and staff of the erstwhile Non Conventional Energy (NCE) Cell under the Department of Rural Development forming the core group of the Directorate of New and Renewable Energy. The Department has also been mandated to take up hydel projects up to 1 MW. Therefore, the Department of NRE has 2 wings viz. NCE and Hydro Wing.

Aims and Objectives

- To harness the environment friendly renewable energy sources and to enhance their contribution to the socio-economic development of the State.
- To meet and supplement rural energy needs through sustainable RE projects.
- To provide decentralised energy supply to agriculture, industry, commercial and household sector.
- To supplement efforts in bridging the gap between demand and supply of power, with renewable energy sources and strengthening the grid system and evacuation arrangements for RE projects.
- To support efforts for developing, demonstrating and commercialising new and emerging technologies in the RE sector, and to this end, help establish linkages with national and international institutions for active collaboration.
- To create public awareness and involve users/local community along with capacity building in establishing, operating and managing RE projects.
- To establish dedicated renewable energy Special Economic Zones (SEZ) to promote renewable energy projects.
- To give necessary support and facilitation to the entrepreneurs and investors to successfully implement RE projects to produce more renewable energy without delay and to attract more investment in State by private developers.
- To initiate necessary measures in energy conservation as per the guidelines of Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India.



Basket making in the solar light in Sailhem village, Peren District, Nagaland.

- To create direct and indirect employment opportunities especially in rural and backward areas.

Development of RE in the State

Vision: To harness green and clean RE sources for environmental benefits and to augment energy security.

Mission: Having RE projects across the State either on grid or off grid mode, will substantiate the total power generation and reduce the import of energy from the grid (Table 1). The Department also mandates the conservation of energy by taking necessary energy efficiency and energy conservation measures in industrial, commercial and government establishments including domestic buildings.

Table 1. Ongoing and planned activities (2011-12) under the Department of New and Renewable Energy, Nagaland

Programme	Target	Remarks
Solar power plant	742 kWp	Ongoing
Solar water heating system (SWHS)	3170 sq m	Ongoing
Solar City	Kohima	Master Plan completed
	Dimapur	Data collection completed
Solar street lights	136 villages	DPR submitted
Solar water pumps	12 locations	DPR under preparation
Hydro Power	1 MW	Ongoing
	17 sites	Survey ongoing
Biogas family size	1000 numbers	Ongoing
Biomass gasifier	2 sites	Ongoing
State Energy Park	1	Ongoing
Wind-solar hybrid	20 kW	DPR under preparation
Remote village electrification (RVE)	38 villages/ hamlets	DPR under preparation

Table 2. RE implementation in 8 villages in Peren District, Nagaland (2010-2011)

Name of Village	Households	Solar home light (SHL)	solar street lights
Shailhem	74	74	7
Phaikholum	49	49	5
New Soget	64	64	6
Old Soget	89	89	8
Songngou	44	44	4
Lower Sinjol 'A'	46	46	4
Khelma	119	119	10
Songsang	64	64	6
Total	**549**	**549**	**50**

Implementation: The Department of New & Renewable Energy has been making efforts to create conditions conducive to private/ public/community participation and invite investors in RE power projects in the State.

One of the tasks undertaken by the Department was to identify the unelectrified villages/hamlets in the State. Intensive survey and data collection was carried out which was coordinated and cross verified with the Department of Power to ascertain whether these villages/hamlets were included in the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) scheme. Clearances were obtained from the Department of Power for 8 villages under Peren District in the first phase (Table 2). The Detailed Project Report (DPR) was submitted to MNRE, which was later approved and sanctioned during 2010-11.

Happy owners of a solar light in Sailhem village, Peren District, Nagaland.

A Prayer meeting under the solar light at Khelma village, Peren District, Nagaland.

Success Story: People speak

Khelma, is one of the villages that has been covered under the RVE programme. Expressing his pleasure and satisfaction at light being available TS Jem, the village chief said it was a dream come true and it was like being in paradise. He said, now with the light, the children could study and the elders could work on handicrafts. He was sure that their economy would improve in the days to come.

Challenges: While carrying out the survey as well as during the commissioning of the projects for these villages, poor road communication was one of the major hurdles for the department officers and staff. Head loading of materials had to be done in some of the villages. Village meetings were held and awareness training on RE with special reference to SHL systems and solar street lights was imparted to the villagers. A Village Energy Management Board was set up in all the villages for up keep and maintenance of the solar systems. Third Party Monitoring was carried out by Nagaland University.

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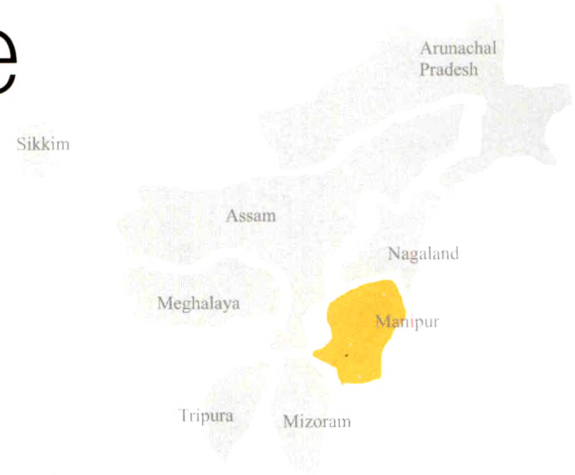
Manipur
Flying High with Renewable Energy

To upgrade Imphal Airport with night landing facility it was decided that solar powered obstruction lights (SPOLs) would be installed on 4 hills surrounding the Imphal valley.

L Manglem Singh



Map not to scale

Manipur literally meaning 'a jewelled land' nestles deep within a lush green corner of north east India. The total area covered by the State is 22,327 sq km; it is bounded by Nagaland in the north, Mizoram in the south, Assam in the west, and by the international border with Myanmar in the east.

The State Nodal Agency

Manipur Renewable Energy Development Agency (MANIREDA) was set up by the State Government as an autonomous government institution for implementation of all the renewable energy (RE) schemes/programmes in the State and designated as the State Nodal Agency on 31 March 1999. The Agency is a registered Society under the Societies Registration Act 1989.

Although MANIREDA has implemented RE projects at selected locations purely on the basis of availability of RE resources of the specific site, no resource assessment on overall potential of RE in the state has been carried out

A solar panel on display at a floating hut in Loktak Lake, Champu Khangpok, Bishnupur District, Manipur.

RVE programme, Santing village, Churachandpur District, Manipur.

Table 1. Status of installed capacity and projected targets of various RE power/electrification projects in Manipur (in kW).

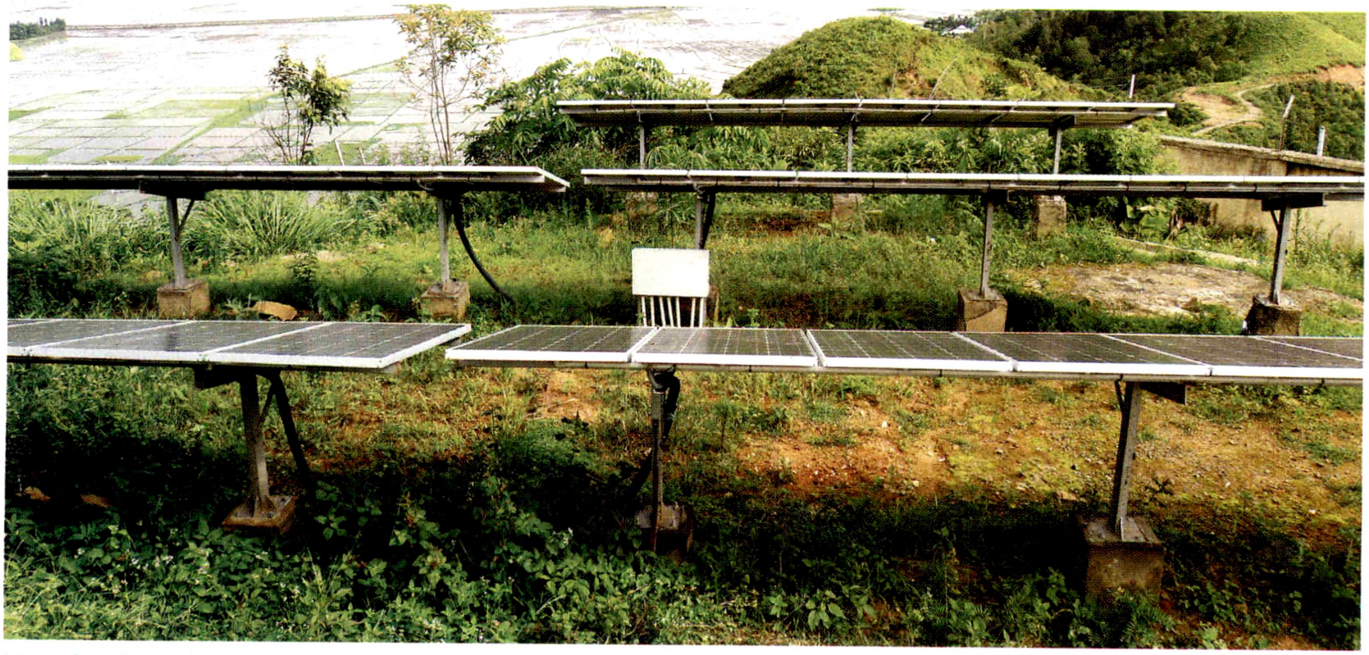
Capacity	Cumulative up to 31 March 2010	Cumulative up to 31 March 2011	Projected cumulative up to 31 March 2012	Projected cumulative up to 31 March 2013	Projected cumulative up to 31 March 2014	Projected cumulative up to 31 March 2015
Wind-solar hybrid systems	140.00	140.00	160.00	200.00	250.00	300.00
Solar thermal	48.00	48.00	5058.00	12558.00	20058.00	27558.00
Biomass based	600.00	600.00	600.00	600.00	600.00	600.00
Small hydro	35.00	435.00	450.00	650.00	750.00	850.00
Solar photovoltaic	1514.25	1715.48	2871.94	3871.94	4871.94	5871.94
Total	2337.25	2938.48	9139.94	17879.84	26299.45	35179.94
Total (MW)	**2.33**	**2.93**	**9.13**	**17.87**	**26.29**	**35.17**

till date. The matter was discussed as one of the important points in the meeting presided by Dr Farooq Abdullah, Minister for New and Renewable Energy with Ministers and officials of the north east region (NER) held on 2 July 2011 at New Delhi. The representatives of NER requested the Ministry of New and Renewable Energy (MNRE) for a detailed resource assessment of various resources of RE in the region on priority basis.

Development of Renewable Energy in the State

Commendable contributions have been made by MANIREDA for the promotion of RE in the State. Altogether installed capacity of about 3 MW has been achieved by the agency till 31 March 2011 through various RE sources such as solar photovoltaic (PV) (1715 kW including demonstration projects), small hydel (435 kW), wind-solar hybrid (140 kW including ongoing near completion projects), biomass (600 kW), solar thermal (48 kW) etc.

More than 200 remote villages/hamlets in difficult hilly regions were electrified through available RE sources and with active participation of the beneficiaries by constituting village energy committees (VECs) in all the beneficiary villages. The status of installed capacity and projected targets of various RE power/electrification projects in the State are given in Table 1.



View of Imphal Valley and the SPOL panels from the Heibokching hilltop

The Heibokching hilltop SPOL

In the event of complete no sunshine days during monsoon/cloudy days, the storage capacity of the tubular plate batteries is able to supply 3-4 days system autonomy.

Success Story

Flying in the dark with solar powered obstruction lights: In order to upgrade Imphal Airport with night landing facility lights were to be installed on 4 hills surrounding the Imphal valley. Since there is no grid lines in these hills it was decided that solar powered obstruction lights (SPOLs) would be installed. The Government of Manipur through the Transport Department entrusted MANIREDA with the installation of solar power plants at the 4 hilltops (Table 2). Expenditure for the four projects was borne by the State Government.

Table 2. Details of the 4 hilltops on which the SPOLs are installed

Name	Area/District	Direction
Nongmaiching Hill Top	Imphal East District	East of Airport
Phunal Maring Hill Top	Imphal East District	South east of Airport
Heibokching Hill Top	Imphal West District	South of Airport
Chingphu Hill Top	Bishnupur District	West of Airport

(Presuming the runway strip at Imphal Airport is in the east-west direction).

The necessity: These hills are located in close surrounding of the airport. In order to facilitate night landing and also to prevent any eventualities during take-off and landing at night, solar powered obstruction lights are placed at the top of these hills mainly to indicate obstruction of the hills to the pilots.

The timelines: Approval for installation of the 4 SPOLs was accorded by the Executive Committee of MANIREDA in October 2008 and work orders were issued in November 2008. Completion of installation/handing over of these SPOLs by MANIREDA to Transport Department was done by 26 February 2009 for three sites, except Nongmaiching hilltop, which was completed on 14 July 2009.

The challenges: Initially, as there were no approach roads to these four sites, roads had to be made to take the materials required for the civil work as well as the solar PV modules, batteries, hardware etc. of the project. Even now, the roads to the Nongmaiching and Phunal Maring sites are difficult and not easily accessible which sometimes hampers the routine maintenance work.

On cloudy days: In the event of complete no sunshine days during monsoon/cloudy days, the storage capacity of the tubular plate batteries at the hilltops (@ 600 VA at 96 V per site), is able to supply three to four days system autonomy (capable of supplying power) easily. The solar plates however are capable of charging the batteries with some intensity (though less powerful) even on cloudy/less sunshine days. All the power plants are working satisfactorily since the last 2 years.

Maintenance: MANIREDA is responsible for 5 years comprehensive maintenance contract of the power plant. Further extension of maintenance period will be considered with approval of the State Government.

The night landing facility has changed the lives of the people. Improved connectivity with the rest of the country has its own cascading effect and implications for the State as a whole. ❂

Night landing trial conducted

A trial run for aircraft landing at Tulihal Airport during night was successfully conducted today. A small aircraft with 10 officials of the Airport Authority of India (AAI) on board conducted successful landing and take-off trials at Imphal airport tonight. Notably, installation of night landing facility at Imphal airport was one of Chief Minister O Ibobi's priority visions and he was duly supported by Prime Minister Dr Manmohan Singh. To facilitate night landing at the airport, four Solar Powered Obstructing Lights have been installed in different directions of the airport.

The Sangai Express, 22 March 2010.

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Success Story

State RE Education Park: In the year 2007, the State set up RE Education Park in Tripura University Campus at Agartala. The park was setup on 4 acres with a cost of Rs. 184 lakhs, out of which MNRE's share was Rs. 77.98 lakhs and state share was Rs. 106.02 lakhs.

Table 1. The main RE devices installed in the State Renewable Energy Education Park

- ▲ 10 kW solar power plant
- ▲ 10 kW gasifier power plant
- ▲ Working exhibits of wind power
- ▲ Micro hydel
- ▲ Models of tidal, geothermal energy
- ▲ Fuel Cell
- ▲ Solar street lights
- ▲ Solar cookers
- ▲ Solar road traffic flashers
- ▲ Solar powered cars for children
- ▲ Battery operated solar bicycles
- ▲ Battery operated 3-wheelers
- ▲ Solar boats etc.

Solar street light installed under RVE programme at Wahtoko Para, West Tripura District, Tripura

In the Park, all renewable electricity devices that are available in the country today are installed and demonstrated for students and the common people (Table 1). The exhibits of the park show how our daily electricity needs can be met through RE sources. Truly, this park is playing a vital role in dissemination of information in the field of new and renewable sources of energy to the public at large. ✪

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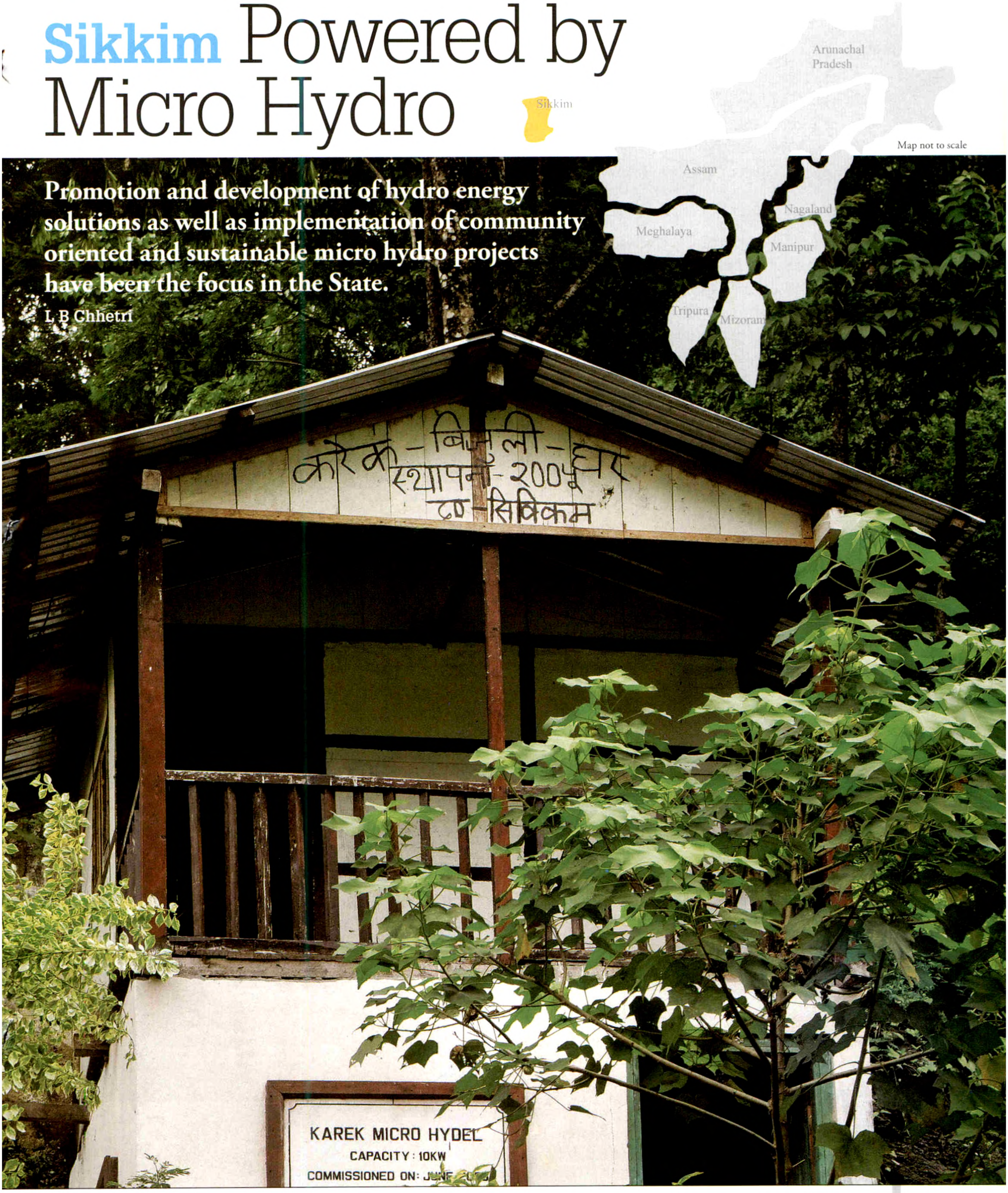
Sikkim Powered by Micro Hydro

Promotion and development of hydro energy solutions as well as implementation of community oriented and sustainable micro hydro projects have been the focus in the State.

L B Chhetri



Sikkim is a small hilly state, bounded by vast stretches of the Tibetan Autonomous Region in the north, the Kingdom of Bhutan in the east, Nepal in the west and the state of West Bengal in the south. The State has a total area of 7,096 sq km and stretches over 112 km from north to south and 64 km from east to west.

The State Nodal Agency

The Sikkim Renewable Energy Development Agency (SREDA) was constituted and registered as a non-profit society in the year 1999. It is the designated State Nodal Agency (SNA) of the Ministry of New and Renewable Energy (MNRE) and owns the mandate for implementation of all renewable energy (RE) programmes in the State. SREDA is actively involved in various programmes of the government like National Biogas and Manure Management Programme (NBMMP), solar-wind hybrid systems, solar water heating and photovoltaic (PV) systems, education parks, and micro hydel projects.

Development of Renewable Energy in the State

Micro Hydro Projects - The Community Centred Approach: Amongst many developments in the field of RE, SREDA has been successful in implementing community oriented and sustainable micro hydro projects. Promotion of development of hydro energy solutions in the State has been the focus of the Agency lately. A very notable aspect of this development is the focus on community development through the use of hydro energy. This implies that a project is wholly owned, maintained and managed by the local community. A Village Electricity Committee (VEC) is formed in the potential village and after design, implementation and commissioning of the hydro plant; the ownership is transferred to the VEC. SREDA remains in the background, and provides technical support when required. The VEC fixes, collects and manages the revenue generated from the consumption in the village and the excess funds collected are utilised in local area development, e.g. footpath construction, irrigation channel repair, school repair, etc. Upon the arrival of the state grid, the power project is augmented to provide arrangement for synchronising with the gird to feed-in the excess energy generated by the plant. In essence, the plant would operate at maximum plant load factor.

Achievements: The Government of Sikkim has tied up with the Climate Change Division (CCD), Swiss Embassy and SREDA has been the cynosure of this collaboration.

> **Geographical Information System (GIS) based mapping of all the potential streams of the State has been proposed and initiated by SREDA.**

The CCD has decided to support development of micro hydro projects in the State through SREDA and a Micro Hydro Project Development Unit has been established within SREDA. The objectives of this collaboration are:

- Micro hydro power potential mapping of streams in Sikkim;
- 2x200 kW Upper Hee Khola (UHK) micro hydro demo project; and,
- Micro/mini hydro project policy development.

An inception workshop for mini/micro hydro power development in the State was held in November 2010 in Gangtok preceding which SREDA was awarded the mandate by the State Government to develop power plants up to 500 kW. The workshop was successful in identifying the challenges involved, and measures to counter them were also formulated.

With the help of the Swiss technical guidance, a 400 kW Upper Hee Khola mini hydro project is being planned in

Solar water heating system (SWHS) at Namchi Zilla Bhawan, South District, Sikkim

A wind-solar hybrid street light at Assangthang, South District, Sikkim

West Sikkim. This plant is to showcase the new technologies in design and construction of small hydro plants in the State, and shall also demonstrate an ideal community owned and driven model in the region. Besides this model plant, a 80 kW Brum Khola Micro Hydro Plant is being designed and developed by SREDA. This plant shall provide energy to an isolated hamlet where no electrical grid is present. The community centred model shall be followed here as well.

GIS Mapping of Potential Streams for Micro Hydro Development: Geographical Information System (GIS) based mapping of all the potential streams of the State has been proposed and initiated by SREDA. It was felt that if data attributes of potential sites and streams could be collected in a GIS database, the information would be useful for planning of future projects and would also help in coordination with other departments of the State like water supply, irrigation, etc. since they share the same water resource. The common attributes for mapping would include stream discharge, stream slope, grid outreach, energy demand, population density, water availability, rainfall data, road connectivity, etc.

Micro Hydro Policy: The lack of policy on micro hydro projects in the State has been a deterrent to effective planning and implementation of projects. The need for a policy confined to micro/mini hydro development was felt and SREDA has taken the initial step toward preparation of such a draft policy. In this regard, the CCD, Embassy of Switzerland has come forth and is helping SREDA in drafting the policy. The best practices of Switzerland and other parts of the Indian subcontinent are being analysed and would be taken into account in the draft.

Success Story

The 10 kW Karek micro hydro project in South Sikkim portrays the success of SPEDA in a definitive way. Installed with a hydraulic head of 9 m and a discharge of 0.20 cumec, the plant runs a single unit pump as turbine (PaT) to generate 10 kW firm power at 3-phase, 415 V, 50 hz supply. The plant caters to the basic lighting needs of 92 households including a Hindu shrine and a primary school. The once dark and kerosene dependent village, is now gleaming with a luminous self-owned electrical lighting systems. The plant is maintained, run and managed by the VEC and has become an example hub for capacity building and self-sustainability.

Following the successful commissioning of Karek micro hydro project, the 7 kW Banjhakri micro hydro project was installed in an energy park and caters to the energy requirements of the park in a stand alone mode of operation. A 20 kW Ghor micro hydro project in North Sikkim and a 25 kW Biri Khola micro hydro project in West Sikkim are under commissioning stage.

Way Forward

With the growing international awareness on climate change and its mitigation efforts, RE has a very big role to play in developing countries like ours. SREDA, being the SNA for RE, has been striving to keep itself updated and has been putting together all efforts to etch a name in the RE sector in the country. The Swiss expertise, at this juncture, could provide the required thrust to these positive developments in the State. ✪

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Smart Grids in India

India is steadily venturing into renewable energy resources like wind and solar. With such unpredictable energy sources feeding the grid, it is necessary to have a grid that is highly adaptive (in terms of supply and demand). A good electric supply is one of the key infrastructure requirements to support overall development, hence, the opportunities for building smart grids in India are immense.

Navneet Gupta and **Apurav Jain**

To understand a smart grid's benefits and applications it is important to first understand the working of the system that is presently being used. In the current system, the end user measurements are mostly with billing in mind, and not control. The other measurements in the grid are few and limited. The sources of power are also restricted to conventional power plants like coal fired or hydro power plants. The tariff rates are flat and are not related to demand or supply.

Smart Grid is a nebulous term spanning various functionalities geared towards modernising the electricity grid. At its core, a smart grid utilises digital communications and control systems to monitor and control power flows, with the aim to make the power grid more resilient, efficient and cost effective. The basic objectives of smart grids are to enable informed participation by customers; accommodate all generation (solar, wind etc.) and storage options; enable new products, services, and markets; provide the power quality needed for the range of needs in a 21st century economy; optimise asset utilisation and operation efficiently; address disturbances through automated prevention, containment and restoration; and operate resiliently against all hazards. The various components and the interlinkages between them for implementation of a smart grid are shown in Fig 1.

Role of Renewable Energy

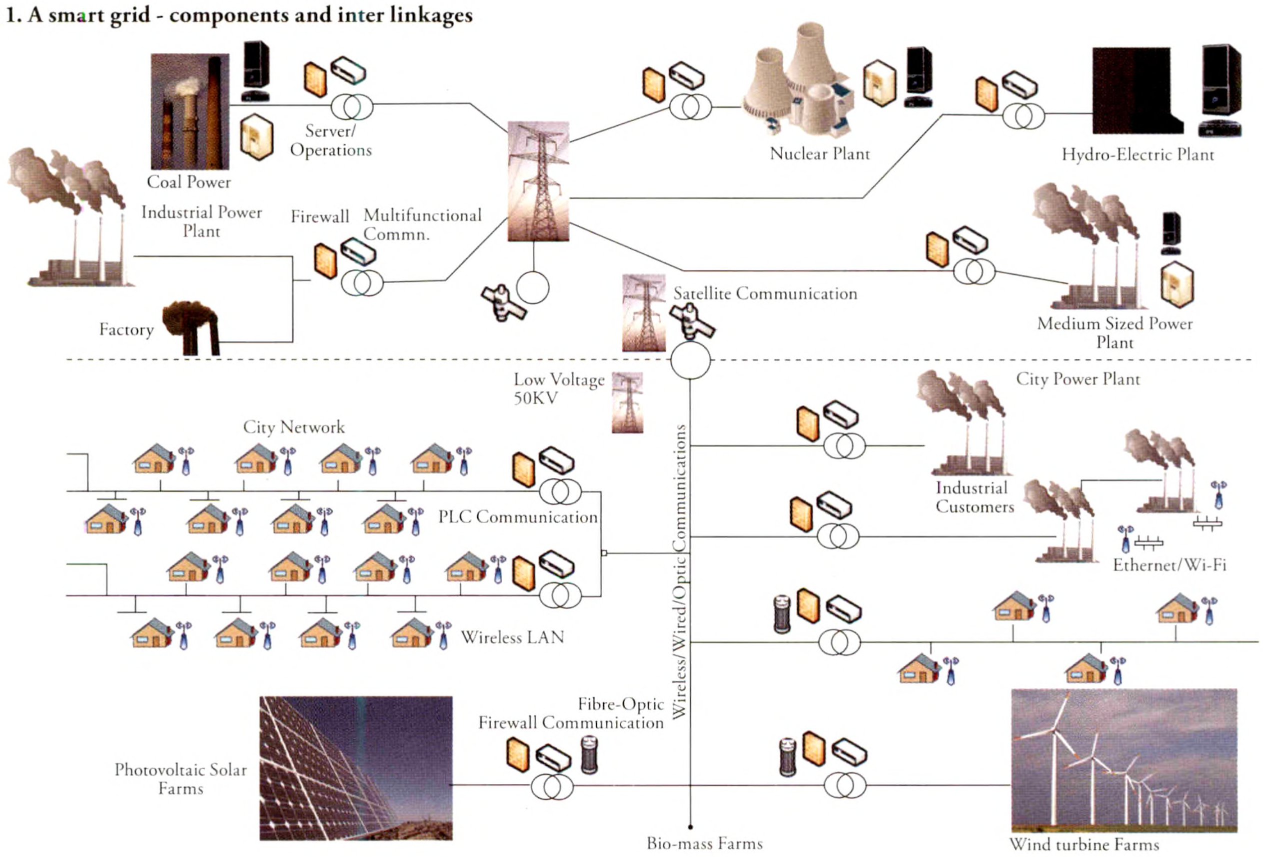
The above situation makes it imperative to harness the renewable energy resources wherever and whenever possible. Renewable energy (RE) is no longer 'alternate energy', but will increasingly become a key part of the solution to the nation's energy needs. In fact, a beginning has already been made and it is an important component of India's energy planning process now. It has the potential to resolve the decentralised energy needs of the remotest corner of the country.

Need for smart grids in India

According to the Ministry of Power, India's transmission and distribution losses are amongst the highest in the world, averaging 26 per cent of total electricity production, and as high as 62 per cent in some states. These losses do not include non-technical losses like theft etc.; if such losses are included, the average losses are as high as 50 per cent.

India losses money for every unit of electricity sold, since India has one of the weakest electric grids in the world. Some of the technical flaws in the Indian power grid are - it is a poorly planned distribution network, there is overloading of the system components, there is lack of reactive power support and regulation services, there is low metering

Fig 1. A smart grid - components and inter linkages



Smart grid efforts in India

Implementing organisation	Details
Bangalore Electricity Supply Company Limited (BESCOM), Bangalore, Karnataka	USD 100 million smart grid pilot project.
North Delhi Power Limited (NDPL), New Delhi	Collaboration with GE for smart grid.
Indian Institute of Technology Kharagpur (IITK) and Indian Institute of Technology Madras (IITM)	Collaboration with IBM for smart grid research.
Management Development Institute (MDI), Gurgaon, Haryana	Smart grid educational programme at the School of Energy Management.

> **With the move towards smart grids, the prevailing policy and regulatory frameworks must evolve in order to encourage incentives for investment.**

efficiency and bill collection, etc.

India is venturing very fast into renewable energy (RE) resources like wind and solar. Solar has great potential in India with its average of 300 solar days per year. The government is also giving incentives for solar power generation in the form of subsidies for various solar applications; and has set a goal that solar should contribute 7 per cent of India's total power production by 2022. With such high targets, solar is going to play a key role in shaping the future of India's power sector.

A lacuna of renewable resources is that their supply can be intermittent i.e. the supply can only be harnessed during a particular part of the day, like day time for solar energy and windy conditions for harnessing wind energy, also these conditions cannot be controlled. With such unpredictable energy sources feeding the grid, it is necessary to have a grid that is highly adaptive (in terms of supply and demand). Hence, the opportunities for building smart grids in India are immense, as a good electric supply is one of the key infrastructure requirements to support overall development.

Smart grid technologies

Smart metering/demand side management: Smart meters are microprocessor based devices that provide a two way communication capability. They help homeowners and the suppliers to manage the respective electricity usage and supply in a more efficient and cost effective manner. With the help of the information provided by such smart meters the power companies will have the capability to set up real time pricing systems for electricity.

Virtual power plants: The goal of virtual power plants (VPPs) (Fig 2) is to allow discrete energy resources (DERs) to access the energy market i.e. to feed the electricity grid constantly and reliably.

Micro grids: A micro grid (Fig 3) is a cluster of local DERs and loads in such a way that an operation is possible within the grid or in independent mode. Usually it is connected at the low voltage level but sometimes also at the medium voltage level.

All these technologies can be used in India in different forms depending on the applications. Different algorithms can be used for the control of smart grids, VPPs etc.

Challenges and solutions

Policy and regulation: No defined standards and guidelines exist for the regulation of smart grid initiatives in India. The current policy and regulatory frameworks were typically designed to deal with the existing networks and utilities. With the move towards smart grids, the prevailing policy and regulatory frameworks must evolve in order to encourage incentives for investment. The new framework will need to match the interests of the consumers with the interests of the utilities and suppliers to ensure that the societal goals are achieved at the lowest cost to the consumers.

Cost: If smart grids had made easy business sense, they would have been the norm everywhere. Cost is clearly one

Fig 2. A virtual power plant (VPP)

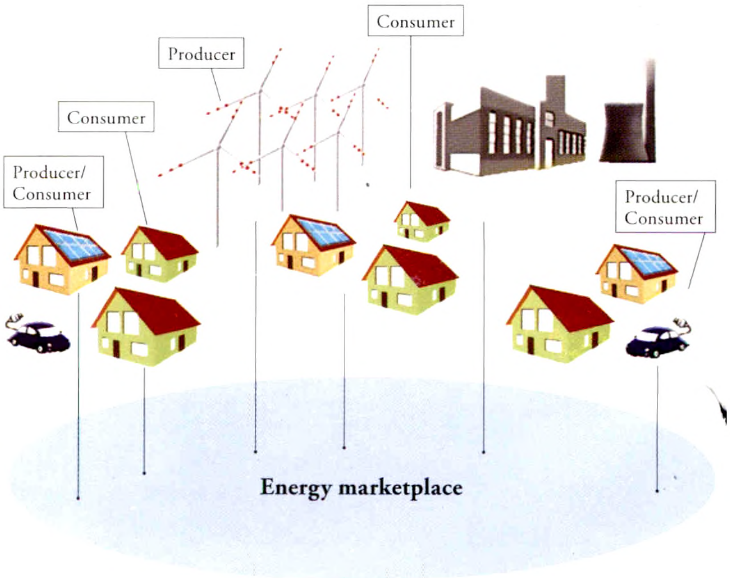
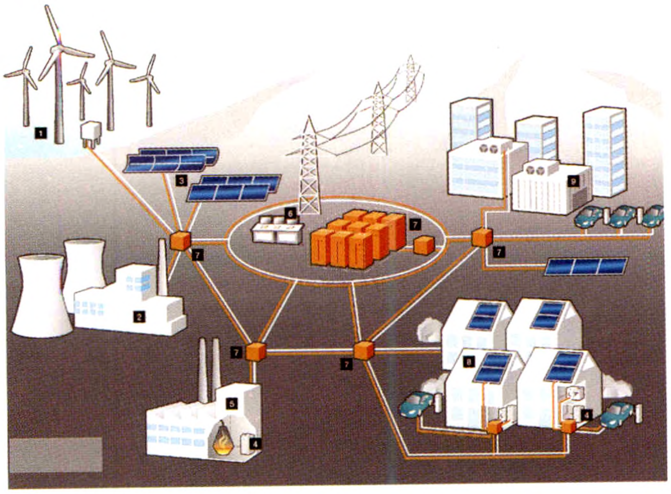


Fig 3. A micro grid



of the biggest hurdles in implementing smart grids. Some older equipment that cannot be retrofitted to be compatible with smart grid technologies will have to be replaced. This may present a problem for utilities and regulators since keeping equipment beyond its depreciated life minimises the capital cost to consumers. The early retirement of equipment may be an issue. Cost of implementing smart grids runs in crores of rupees. The benefits from smart grids are not just meter readings but include reduction in equipment failure, better quality of supply and greater use of green energy. It takes careful societal cost-benefit analysis, beyond return of investment calculations, to justify the use of a smart grid.

Lack of awareness

The level of understanding of consumers about how power is delivered to their homes is often low. So, before going forward and implementing smart grid concepts, the consumers should be made aware of what a smart grid is, how it can contribute to a low carbon economy and what benefits they as users can drive from smart grids. Therefore, consumers must also be made aware of their energy consumption pattern at home, offices, etc.; policy makers and regulators must be very clear about the future prospects of smart grids; and the utilities need to focus on the overall capabilities of smart grids rather than mere implementation of smart meters.

Cyber security and data privacy

With the transition from analogous to digital electricity infrastructure comes the challenge of communication security and data management. Since digital networks are more prone to malicious attacks from software hackers, security becomes a key issue. In addition to this, concerns on invasion of privacy and security of personal consumption data arise. The data collected from the consumption information could provide a significant insight into a consumer's behaviour and preferences. This valuable information could be abused, if correct protocols and security measures are not adhered to. These issues should be addressed in a transparent manner, to minimise any negative impact on a customer's perception. The systems should be designed with security as a priority and should be well protected against software hacking and other such malicious activities.

> **Any smart grid plan must be adaptable to the unique needs, cultural and political realities, and resource constraints.**

The way forward

It is very difficult to analyse the performance and benefits of smart grids without actually implementing them. Techno-commercial pilot projects can offer interesting potential demonstrations of various benefits of smart grids. Overall, the major elements of any such projects should include, developing a smart grid vision, conducting appropriate awareness to educate and develop a consensus, identifying viable funding options and implementing appropriate policy and regulatory actions to set common standards and encourage innovation.

In tandem with these actions, certain pilot projects could be implemented to demonstrate their commercial viability. Small and medium sized projects should be tried at both, the rural and urban level to decide upon an optimal solution, which can be implemented, on a larger scale.

It should be emphasised that any plan must be adaptable to the unique needs, cultural and political realities, and resource constraints of different regions, states and localities. Perhaps the gravest error at this early stage of smart grid development would be to adopt a rigid, top-down and 'one size fits all' approach to achieve a smart grid vision. In conclusion, if implemented appropriately, smart grids can provide a very green and optimal solution to India's energy needs. ✪

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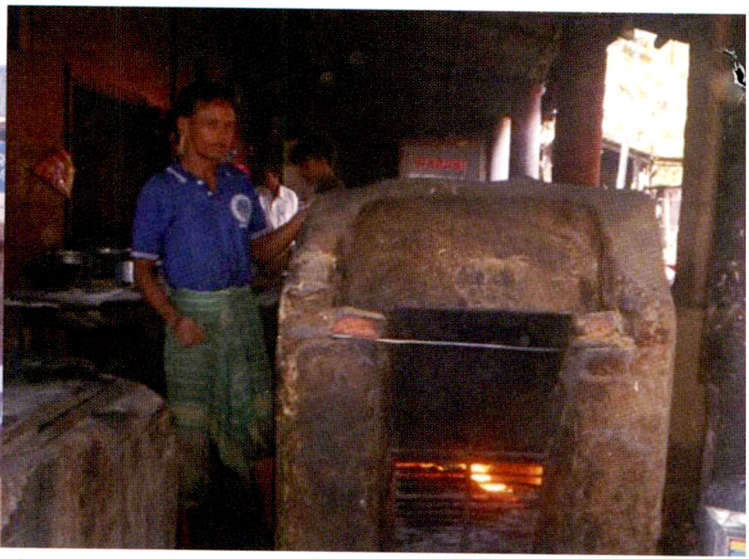
Turning restaurants in Assam greener

with Rice Husk

Rice husk has started getting entry into the restaurants and roadside eateries of Assam as an alternate cooking fuel primarily due to its cost competitiveness vis-à-vis conventional fuel.

D C Baruah

Picture 1. Rice husk stored in a roadside eatery's premises.



Picture 2. Husk fired *chullah*.

Roadside food stalls are refreshing locations for travellers and these are increasingly being taken up as small scale entrepreneurial activities in Assam. Today, restaurants/dhabas are located alongside the national highways, major roads and in commercial places. With the increase in number of automobiles, particularly small cars, in recent times the roadside commercial activities have also picked up. The increased burden on petroleum, increased vehicle population and surge of development along the highways have become serious concerns.

Thermal energy demands for preparation of food in the restaurants and roadside eateries are escalating due to increase in their number and activities. Wood, coal and kerosene have been the conventional fuels to fulfil such thermal energy requirements. However, wood is collected from local forests and its supply is diminishing, mainly due to deforestation without consideration for re-plantation. Moreover, wood has other competitive uses and thus it is becoming unviable economically as a fuel. Similarly, coal and kerosene are becoming costlier. The accelerated

Table 1. Annually available rice husk estimated for ten districts of Assam

District	Available rice husk (million kg)
Darrang	80
Goalpara	123
Kamrup	85
Lakhimpur	51
Dibrugarh	35
Nagaon	68
Sivasagar	67
Cachar	58
North Cachar	4
Karbi-Anglong	32
Total	**603**

costs of the conventional fuels makes it necessary to look at alternatives for restaurants; as a major portion of their expenditure is attributed to cooking fuel.

Rice husk as a saviour

Rice husk has started getting entry into the restaurants and roadside eateries of Assam as an alternate cooking fuel primarily due to its cost competitiveness vis-à-vis conventional fuel. Rice is grown extensively in Assam and the husk could be considered as one of the potential and economically viable agro-residues for the renewable energy (RE) programme (Picture 1). The recent statistics of rice husk available in Assam is provided in Table 1. Annually more than 600 million kg of rice husk is produced by rice farmers of Assam and it is almost evenly distributed throughout the state.

Prospects of agro-residues for fulfilling energy demand are being consistently highlighted and practiced in several places in India and around the world. Use of sugarcane bagasse for cogeneration of heat and power has been the most successful example in our country. Similarly, use of rice husk through gasification and combustion is picking up momentum in some of the rice dominating regions. Thus, appropriate use of rice husk in large energy consuming sectors like restaurants and roadside eateries could be an effective option for the RE programme in Assam. Envisaged benefits through extensive use of this green fuel include reduction of undue pressure on forest cover and financial incentives for rice growers.

> **Appropriate use of rice husk in large energy consuming sectors like restaurants/dhabas could be an effective option for the RE programme in Assam.**

Interventions to reduce unit energy cost

Until recently rice husk was not a commercial commodity in Assam. It was either burnt or dumped near the rice mill. Due to the initiation of its use in restaurants and roadside eateries dhabas and with prospects of extensive use in the future, the cost of rice husk is expected to increase (one prominent local food industry in Sonitpur District of Assam has already installed a 1 MW (thermal) rice husk based gasification unit for biscuit making).

Presently restaurants/dhabas collect rice husk through a supplier from the local rice mills. It is expected that soon rice husk will get an entry into the normal commercial chain like any other item. Further, it is observed that unlike other renewable technologies (like biogas, solar photovoltaic (SPV) etc.), the use of rice husk to replace conventional fuel is taking place on a wide scale, naturally i.e. without intervention of external agencies. However, to sustain it further, steps will have to be taken to address the following issues:

Technology refinement: Presently fireplaces/chullahs of the rice husk fuelled restaurants/dhabas in Assam are designed and constructed by the local artisans (Picture 2). The husk is allowed to pass into the fireplace by gravity, whereas the burnt ash is collected manually from the bottom grate. The air (into the combustion area) and flue gas are circulated by natural circulation using a chimney made of brick and clay. Improvement of chullahs to reduce heat loss and increase thermal efficiency would ensure a reduction in unit energy cost.

Utilisation of ash: Husk fired chullahs generate substantive quantities of ash. In some cases, it is re-circulated into the fields to replenish the soil with the useful minerals left after combustion. The appropriate utilisation of this component, including silica recovery, would also result in reduction of unit energy cost.

Appropriate research and development activities to cover the discussed and other aspects would assist in the optimum growth of this silent revolution of rice husk utilisation in Assam. ✪

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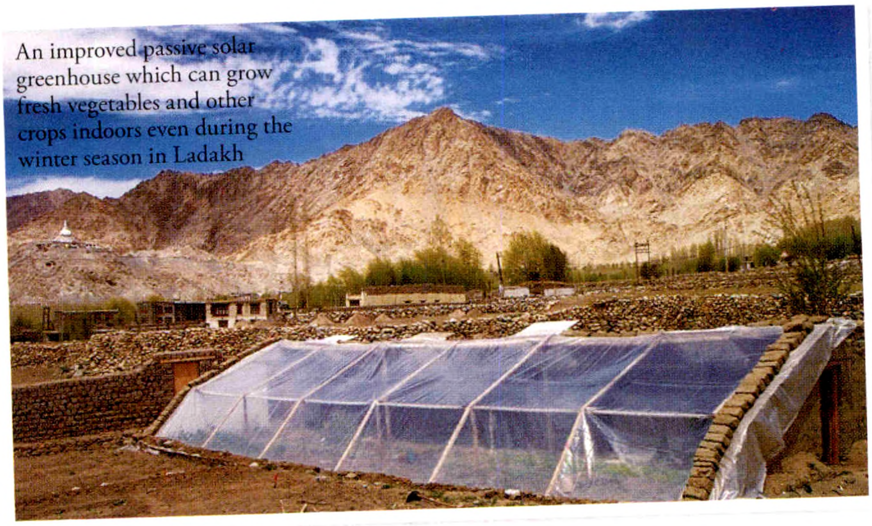
Fresh Vegetables in the Cold Desert of Ladakh

The climate of Ladakh makes it very difficult to grow fresh vegetables in the open for nearly 9 months in a year. The Groupe Energies Renouvelables, Environment et Solidarites (GERES) has developed improved passive solar greenhouses to address this problem.



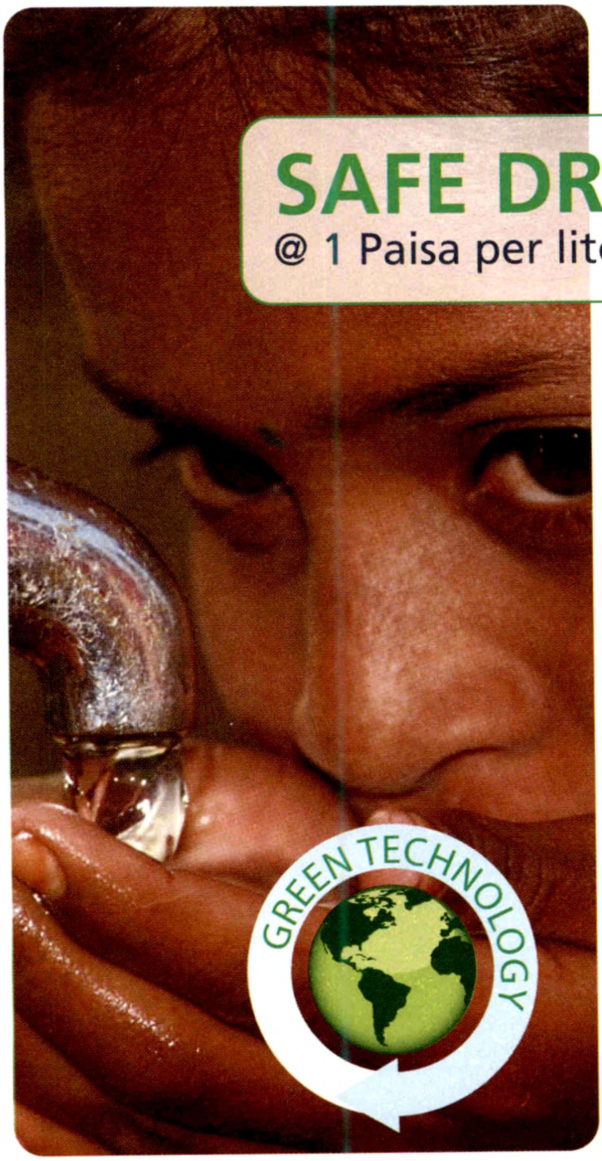
An improved passive solar greenhouse which can grow fresh vegetables and other crops indoors even during the winter season in Ladakh

At an altitude of more than 3500 m above sea level, Ladakh district of Jammu and Kashmir state is a cold desert characterised by cold breeze and a blazing sun. Ladakh receives a very low rainfall as it falls in the rain shadow area. In winters, the temperature can be as low as -25°C. The climate makes it very difficult to grow fresh vegetables and other crops in the open for nearly 9 months in a year as the plants freeze to death because of freezing. Airlifting the vegetables from the plains in winter and bringing them by road in summer is a normal practice, making the fresh vegetables expensive and limiting their availability. Most of the locals rarely get to eat fresh vegetables; as a result, many suffer from malnutrition.

Ladakh experiences clear sunny days for almost 300 days in a year. Exploiting this sunny climate of Ladakh, the Groupe Energies Renouvelables, Environment et Solidarites (GERES) started developing improved passive solar greenhouses to grow fresh vegetables and other crops indoors even during the winter. For the last ten years, GERES is working in this area in collaboration with the Ladakh Environmental Health Organisation (LEHO), Ladakh Ecological Development Group (LEDEG), Leh Nutrition Project and Skarchen and Spiti Transhimalayan Group/Ecosphere (STAG).

GERES developed an improved greenhouse (IGH), to maximise the capture of solar energy during the day, minimise the heat loss at night and thus prevent plants from dying due to freezing. The greenhouses are designed in such a way that they are sufficiently heated using only solar energy and do not require any supplementary heating. Some of the salient features of the improved green houses are:

- The greenhouse is oriented along an east-west axis with a long south facing side.
- This long south side has a transparent cover made of heavy duty polythene with an extra stabilizer to withstand the intense UV rays present in the sunlight. The polythene is built to last for a period of more than five years.
- The north, east and west side walls of the greenhouse are constructed using mud bricks in low and medium snow fall areas and with stone or rock in heavy snow fall areas to enable the green house to absorb maximum heat from the sun during the day and release the stored heat at night



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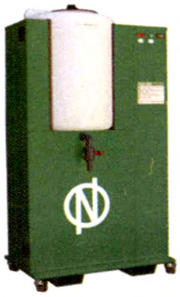
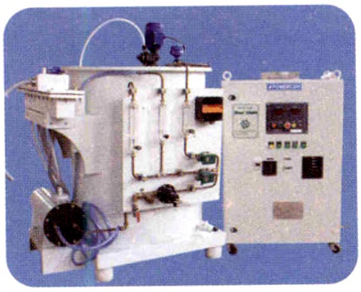


Typical Batch Type



Typical Continuous Type

Solar Mac unit

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to maintain a temperature suitable for healthy growth of plants inside the greenhouse.

- The walls on the north, east and west sides are constructed as cavity walls to help in minimising heat loss from the greenhouse. The 100 mm cavity in these walls is filled with insulating material such as sawdust or straw. The roof is slanted at an angle of 35° to allow maximum direct sunlight during the winter season. At night, the roof is covered with thatch and the polythene and the south side is covered with a cloth or tarpaulin to prevent heat loss.

Except the polythene used for covering the south side of the greenhouse: the entire greenhouse is constructed using locally available material. The main frame of the roof is made using local poplar wood, willow for struts and straw or water resistant local grass for the thatch. Rock, stone, mud bricks or rammed earth are used in walls construction. The polythene sheet has to be procured from places like Mumbai. Local masons are employed to construct the greenhouse by providing special training wherever required.

The greenhouse comes in two sizes: a smaller greenhouse with 4.5 m breadth and 9.7 m length for domestic use and a bigger greenhouse with 4.8 m breadth and 27.3 m length for commercial use. The construction cost of a domestic use IGH is approximately Rs 30,000. The owner of the domestic IGH has to either pay for or collect all the locally available material. The owner also has to provide the labour or pay for the labour required for construction. The NGO pays and provides the doors, vents and the special UV stabilised polythene, which comes to about 25 per cent of the total cost. Some subsidy is given for domestic IGH. Construction of the greenhouses is timed in such a way that they match the agricultural cycle of Ladakh.

GERES monitors the IGH construction by providing methodology and design. LEHO and other local non governmental organisations (NGOs) coordinate in selecting the prospective owners, training them on greenhouse maintenance and operation and providing other support needed for constructing the greenhouse to local owners. A wide variety of vegetables including spinach, coriander, garlic, radish, onions, lettuce, and strawberries are grown in winter. Tomatoes, cucumbers and grapes are grown in autumn and in spring seedlings are grown in the greenhouses.

A greenhouse for domestic use

Spinach, coriander, garlic, radish, onions, lettuce, and strawberries are grown in winter; tomatoes, cucumbers and grapes in autumn and in the spring seedlings are grown in the greenhouses.

IGHs have benefited the people of Ladakh, especially in terms of health. Prior to introduction of IGH, during winter people used to consume fresh vegetables only once or twice in month, but after the IGHs were introduced, the consumption of vegetables has increased to two to three times in a week. On an average, one IGH owner provides fresh vegetables to nine other families and barters with six other families, resulting in health improvement of the people. Villagers are able to save on an average Rs 500 to 1,000 on vegetable purchases as locally grown fresh vegetables cost less as compared to imported vegetables.

Production of fresh vegetables locally also reduces the dependency on imports from the plains, thus saving on expenditure on transportation. According to an estimate of GERES, the 560 greenhouses presently in operation are able to save about 460 tons of carbon emissions per year. IGH has also brought employment opportunities to locals. Around 220 masons and 15 carpenters have received training and support a livelihood through constructing greenhouses. IGHs have increased the income for their owners, as they can earn additional income by selling vegetables and seedlings for cash. Surveys conducted have revealed that on an average an IGH owner earns Rs 8,250 per year by selling their excess produce, which is about a 30 per cent increase in their income level.

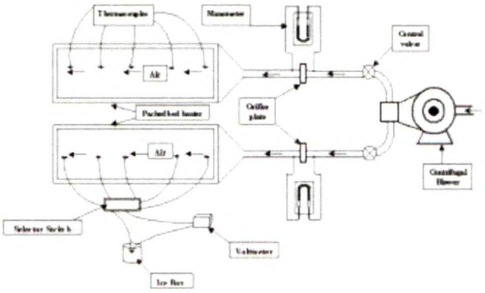
The scale up potential for IGHs in high altitude regions of Himalayan states is very high. In Ladakh alone the potential demand for IGH to produce fresh vegetables for civilian consumption is about 3,000 units, it may double up to 6,000 units if military requirements for fresh vegetables is included. At present technological replacement of UV resistance polythene sheets every 5 years and lack of awareness among the agricultural/horticulture departments at the state level is proving to be a barrier in the promotion of IGHs. The solar passive concepts of south facing glazing, high thermal mass and insulation can also be used in other constructions like individual houses, public buildings, schools, hospitals and government offices etc.

Heat transfer enhancement in packed bed solar air heater

A solar air heater is a simple device to heat air by utilising solar energy having applications in drying agricultural products such as seeds and fruits and also in space heating. The present investigation is taken up with the objective of experimentation on a wire screen matrix to collect data on heat transfer and fluid flow characteristics. The data is presented in the form of Nusselt number plot to bring out clearly the effect of parameters and enhancement in heat transfer.

The experimental setup used in the investigation is shown in the schematic diagram as per Sukhatme (1987) and ASHRAE (1977). Both the ducts had an identical length of 1.60 m, width of 0.62 m, and depth of 0.025 m and were made of softwood; both were inclined at an angle of 25 degree to the horizontal. The smooth (or conventional) duct had an absorber plate of 2 mm GI sheet. The reason for using two ducts in the present set-up was to compare the performance at the same operating conditions such as mass flow rate, insolation and inlet fluid temperature. The packed bed duct had a 2 mm GI sheet having several layers of wire mesh screens arranged one above the other on the upper side of the GI sheet while below it there was 50 mm of thermocol and 2 mm plywood.

The experimental data has been collected by following the procedure described in ASHRAE Standard Handbook (1977) for testing the solar air collector operating in open loop mode. Data pertaining to a given mass flow rate was collected between 11 a.m. and 2 p.m. at an interval of 1 on a clear sky day. Before starting the experiment, all the joints of duct, inlet section, mixing device and pipe fittings were examined for leakage and it was sealed by using glass putty. While recording the temperature, the ice-bath and lead wire for micro-voltmeter were protected from direct solar radiation. The blower was run for an hour and thereafter, the thermocouple readings for wire mesh temperatures at various locations and inlet and outlet air temperatures, pyranometer readings for intensity of solar radiation and manometer readings for pressure drop across the duct were recorded for a particular day. Experimental data were collected for flow rates ranging from 0.0261 to 0.031 kg/s for four set of matrices. First of all a low porosity wire mesh of square shape with 6-layers is used. Afterwards same wire mesh with 5–layers, 4 & 3 was used and again the above mentioned data collected. The parameters measured were: pressure difference across orifice meter, temperature of the absorber plate, inlet and outlet temperature of air in the duct, ambient temperature and intensity of solar radiation.



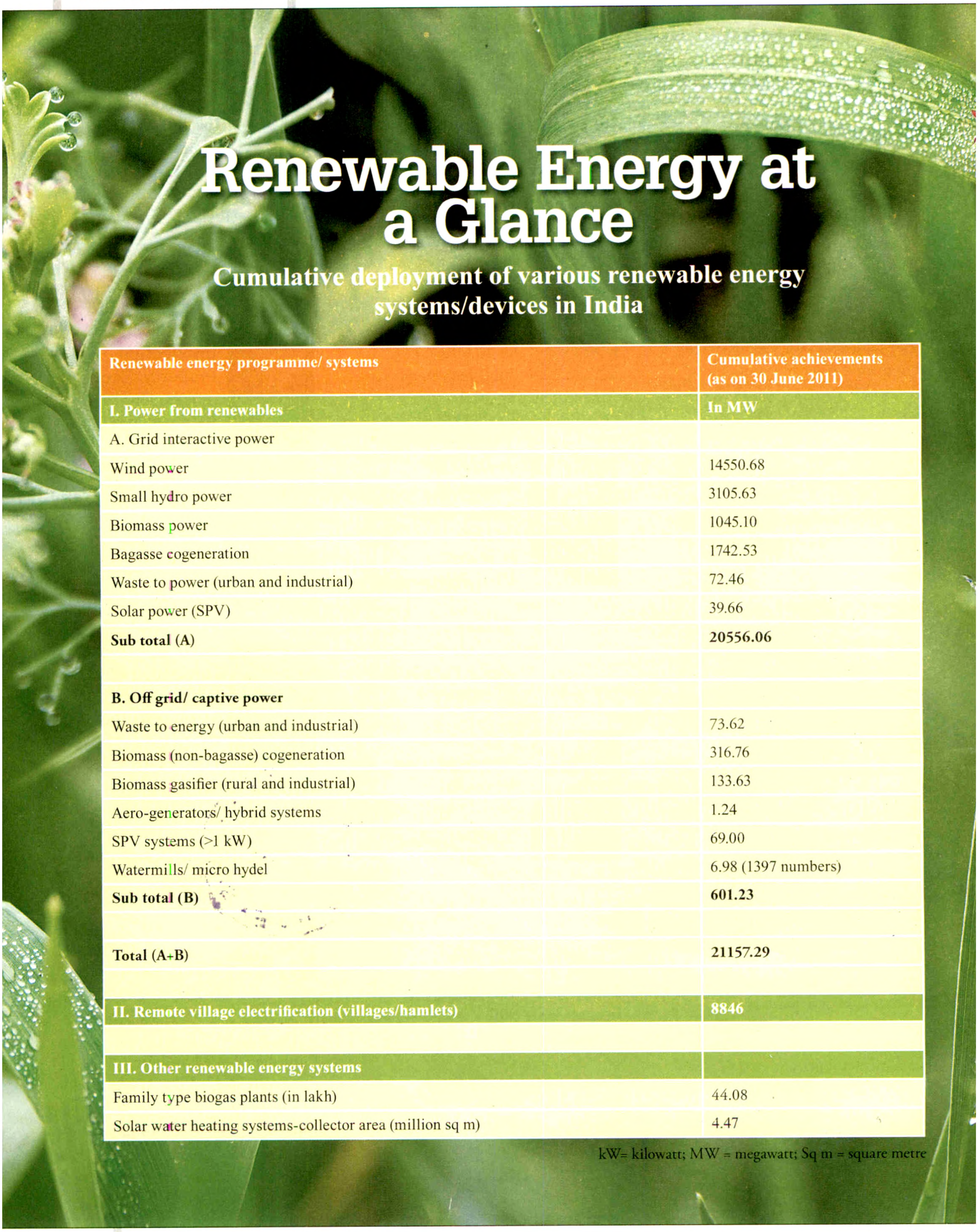
Schematic diagram of experimental set-up

Before collecting the data from the experimental set-up, the system was tested for validity by experimentation on a smooth plate to determine the Nusselts number and friction factor. These values of the Nausselt number and the friction factor were compared with those obtained from the Dittus and Boelter correlation and Blasius equation. The Nusselt number had absolute maximum deviation of 8 per cent while the maximum deviation of the friction factor is 4 per cent from the predicated values by Blasius equation.

It is seen that heat transfer increases as Reynolds number increases. Also, as porosities reduces in the duct, heat transfer increases. The decrease in porosity increases turbulence and thereby increases volumetric heat transfer coefficient and Nusselt number.

On the basis of this investigation on heat transfer characteristics in packed bed solar air duct it is concluded that Packed bed solar air heater having with lower porosity performs better than higher porosity due to greater turbulence. At Reynolds number of 1600, heat transfer enhancement is 70 per cent, 50 per cent and 25 per cent corresponding to porosity of 0.9614, 0.9678 and 0.9743 respectively as compared to porosity of 0.9807.

Source: Research article 'Solar Air Heater' M K Lalji et al. Pages 747-749, Indian Journal of Science and Technology, Vol. 4 No. 7 (July 2011), ISSN: 0974- 6846



Renewable Energy at a Glance

Cumulative deployment of various renewable energy systems/devices in India

Renewable energy programme/ systems	Cumulative achievements (as on 30 June 2011)
I. Power from renewables	**In MW**
A. Grid interactive power	
Wind power	14550.68
Small hydro power	3105.63
Biomass power	1045.10
Bagasse cogeneration	1742.53
Waste to power (urban and industrial)	72.46
Solar power (SPV)	39.66
Sub total (A)	**20556.06**
B. Off grid/ captive power	
Waste to energy (urban and industrial)	73.62
Biomass (non-bagasse) cogeneration	316.76
Biomass gasifier (rural and industrial)	133.63
Aero-generators/ hybrid systems	1.24
SPV systems (>1 kW)	69.00
Watermills/ micro hydel	6.98 (1397 numbers)
Sub total (B)	**601.23**
Total (A+B)	**21157.29**
II. Remote village electrification (villages/hamlets)	**8846**
III. Other renewable energy systems	
Family type biogas plants (in lakh)	44.08
Solar water heating systems-collector area (million sq m)	4.47

kW= kilowatt; MW = megawatt; Sq m = square metre

Volume 5 | Issue 2 | October 2011

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Renewable Energy
Akshay Urja

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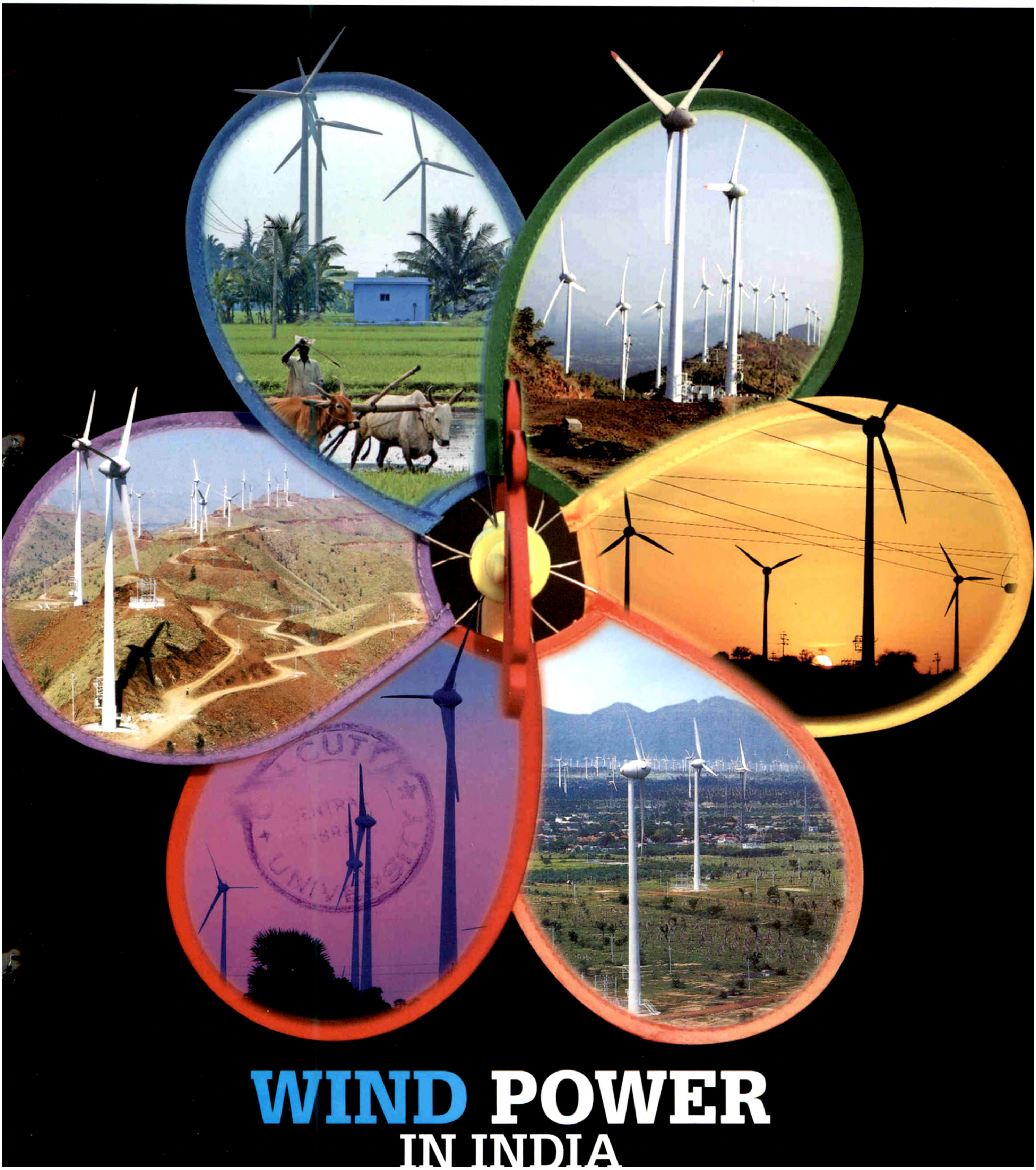

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Renewable Energy
Akshay Urja

Volume 5 ▪ Issue 2
October 2011

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(Published in English and Hindi)

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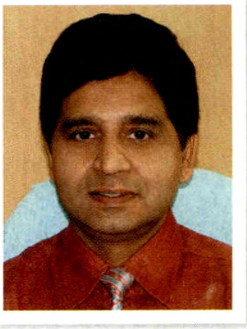
Cover Photo: A collage of various wind farms generating wind energy in the country

Disclaimer: The views expressed by authors including those of the editor in this newsletter are not

From the Editor's Desk

Dear Readers,



Wind as energy source is being utilised by the mankind particularly for sailing, water pumping and grinding grains since ages. In 200 BC, people in China and the Middle East used wind mills to pump water and grind grains. However, the generation of electricity from modern wind turbines started in Vermont, USA in the early 1940s. In India the interest in wind power started in the early 1970s by Department of Science and Technology but the first Wind Energy Programme was launched in 1983 by the erstwhile Department of Non-Conventional Energy Sources.

Two distinct approaches related to wind power development in India were adopted (i) a revisit to the assessment of wind as an energy resource and (ii) strategic development and deployment of wind power hardware. A market-oriented strategy was adopted from inception. This has led to the commercial deployment of the technology rather than being subsidy driven. To aid this approach, demonstration projects were set-up and fiscal incentives provided for development of infrastructure capability. Ministry played a pivotal role in making finances available for setting up commercial wind farms through World Bank and other sources at attractive interest rates.

The first grid connected wind turbine of 40 kW imported from the Netherlands was installed in 1985 in Veraval in Gujarat which could not fetch the expected results. The second wind power plant with total capacity of 1.15 MW was installed in 1986 in Mandvi, Gujarat which was a successful venture. Thereafter, there was no looking back in the success of wind power sector and today with a total installed capacity of over 15000 MW, India ranks 5th in the world after United States, Germany Spain and China.

Wind is one of the fastest growing renewable energy sectors in India. It accounts for about 70 per cent of the total installed capacity in the grid renewable power in the country. However, much remains to be done. The vast offshore potential lies ready to be harnessed.

The MNRE has been giving all possible support for the development of wind energy through proactive policy and regulatory interventions. The Generation Based Incentive scheme, currently valid for wind farms installed before 31 March 2012, has helped independent power producers enter the arena. Feed-in-tariffs and Renewable Purchase Obligations issued and specified by the State Electricity Regulatory Commissions have helped to create a positive impact on the wind energy capacity additions in the respective states.

In this context the present issue focuses on the wind sector in India and the articles in this issue will take you on a journey as they cover the various aspects of 'wind power' in India - from giving an overview of the wind sector in India, to the developments and trends in the technology related to wind, from the challenges faced by the sector in the country to the opportunity presented by RePowering and finally also going into the positives of 'small' wind.

I take this opportunity to invite all who are interested in renewable energy, especially our readers to share their views and experiences with us to enable us to expand the scope and reach of AkshayUrja. Hope each of you, who read this issue, will enjoy it.

Happy reading.

अक्षय ऊर्जा से देश विकास

ARUN K TRIPATHI
<aktripathi@nic.in>

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Letters to the Editor

I am happy to inform you that, I have been receiving the copies of Akshay Urja regularly, since 2010. The contents in the magazine are very useful and informative. We are using the articles as a basis for seminar topics for the students in our college. This is helping to increase the awareness on renewable energy technology and application among the students. The efforts of MNRE and the editor in bringing out such informative and colourful issues month after month are appreciated.

Iranna Korachagaon
Professor, Annasaheb Dange College of Engineering & Technology, Sangli, Maharashtra

I have received Akshay Urja for the first time by post. The contents of the newsletter are very informative. The editorial message given by you also gives ample ideas about energy saving ways and means for the building industry. My heartiest congratulations to you and the members of the team for bringing out this publication.

HRP Yadav
Director (Coordination), HQ Cell, Institute of Engineers, Delhi

I taught 'Non-Conventional Energy Sources' to undergraduate students for nearly 20 years at Nagpur and Marathwada universities. I established solar energy laboratories at Amravati and Aurangabad engineering colleges. Presently I am teaching Energy Conservation and Management at Engineering College Pune for the last 2 years. I came across Akshay Urja and found it very useful for me and my students.

Dr Prof VM Domkundwar,
Pune, Maharashtra

I recently saw Akshay Urja and was quite impressed with its contents.

Dr Avinash K Agarwal
Associate Professor, Indian Institute of Technology, Kanpur

I came across your very beautiful magazine on renewable and green energy sources and activities taking shape in India and it was a pleasure to read it.

Vinayak Patwardhan
Mumbai, Maharashtra

I had the opportunity to read Akshay Urja. It is very appropriate to educate people about the latest developments regarding technology and policy in renewable energy.

Dr Pooran Koli
Asstt. Prof., Solar Energy Conversion and Storage Lab, JNV University, Jodhpur

I found the articles on *Offshore Wind Power* and *Biodiesel from Microalgae: A Potential Renewable Fuel*, in the June 2011 issue of Akshay Urja quite interesting.

A Jagadeesh

I am a regular reader of Akshay Urja and have found it to be one of the best magazines dedicated to renewable energy. It is useful for everyone, especially college students. I am circulating this magazine to my students and colleagues and all eagerly await their turn. I would like to congratulate the Akshay Urja team for their effort in making the magazine informative and interesting.

Anil Dube
Associate Prof., Sandip Institute of Engineering and Management, Nasik, Maharashtra

I came across Akshay Urja, which is published by MNRE and deals with renewable energy. The newsletter is very useful to me as well as my students.

I Kamaluddeen
Annamalai Polytechnic College, Chettinad

It was a pleasure to receive the complementary copy of Akshay Urja. We would like to congratulate you for editing a very useful and educative newsletter, which meets the needs of the time.

DR Goel, Admin. Officer,
Rukmini Devi Public School, Delhi

अक्षय ऊर्जा अपने प्रारम्भ के दूसरे वर्ष (वर्ष 2) से लगातार प्राप्त हो रही है। अतः हमेशा भेजते रहिए।

बजरंग लाल जेठू
लाल भुजा चौक, लांडनु नागौर, राजस्थान

अक्षय ऊर्जा को पढ़कर हमें इस क्षेत्र में हो रही प्रगति के बारे में बेहद उपयोगी जानकारी मिलती रहती है। मैं एक अध्यापिका हूँ और इसका उपयोग अपने विद्यालय में छात्रों को पढ़ाने के लिए भी करती रहती हूँ। आपसे अनुरोध है कि इसमें बच्चों के लिए भी अधिक जानकारी शामिल करें। आपके सफल प्रयास के लिए आपको बधाई।

ज्योति अवस्थी
जबलपुर, मध्य प्रदेश

Dear Reader, Thank you very much for your encouragement. The editorial team of Akshay Urja will make every effort to make this newsletter highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvements in terms of content and presentation. **Editor: Akshay Urja**

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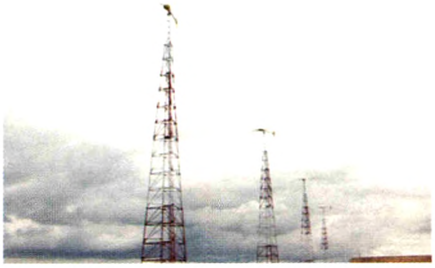
Amongst various renewable energy options, wind energy has emerged as a viable, cost-effective and commercial option for grid connected power generation.



At a time when harnessing of wind power is gaining momentum, the size and the generation capacity of the wind turbines has become a crucial factor. 'Big' seems to be the buzzword, but 'small' also has its advantages.

Replacing old, underperforming wind turbines with modern ones that could offer better returns and more power than before opens up a lucrative opportunity in wind power - that of RePowering.

First waste-to-energy plant in West Bengal

The Berhampur Municipal Corporation (BMC) has planned to generate

renewable energy (RE) from solid wastes. Around 200 tonnes of solid wastes are generated in the town every day. “We have decided to set up a processing plant to utilise the municipal solid waste (MSW) on the public private partnership (PPP) mode very soon”, said Bhim Manseth, Commissioner, BMC.

Generation of energy is one of the better options for utilising municipal solid waste. The other products, which can be generated from solid waste, include manure and industrial oil, he said. BMC has roped in International Finance Corporation (IFC), a member of the World Bank Group, as a consultant for the project. The consultant would conduct the feasibility study and adopt the technology that suits the conditions of the town.

www.business-standard.com,
29 August 2011

20 grid connected solar power plants on-stream

Gujarat, Rajasthan, and Tamil Nadu are front runners among states that have grid connected solar power plants. A total of 20 grid connected solar power plants with capacity of 1 MW or more have been commissioned in the country by July 2011. Of the total capacity of 45.5 MW commissioned, Gujarat has 11 MW, Rajasthan 7.5 MW, Tamil Nadu 7 MW, Karnataka 6 MW, and Maharashtra 5 MW. Andhra Pradesh, Punjab and Delhi have 2 MW each, while Haryana and West Bengal have 1 MW each.

www.thehindubusinessline.com,
29 August 2011

Solar equipment majors eye India as manufacturing hub

With the prospect of a slowdown in the renewable power sector in their home markets, US and European solar power equipment manufacturers are betting big on Indian demand. The global renewable energy majors are not only increasing their presence in the market by participating in equipment-supply tenders but also looking at converting India into a manufacturing hub.

US-based First Solar has identified India’s solar power development programme as a key driver for its investment in the equipment manufacturing capacity expansion projects. Similarly, Germany’s Schott plans to tap the Indian market by expanding its facility for solar glasses at Vadodara. Another German company, REFUsol, expects to triple its business by the end of this year, while Intertek, is bullish on the Indian solar market.

In addition, many tie-ups are being worked out between Indian and overseas companies. India's Vikram Solar has partnered Spanish company Proener to take up engineering, procurement and construction (EPC) contracts of large solar power projects. Gujarat-based Harsha Engineers has entered into a pact with Germany-based Abakus to work as integrator for solar PV applications.

www.financialexpress.com,
28 August 2011

Akshay Urja welcomes new Patron

Shri Gireesh B Pradhan has taken over as the Secretary, Ministry of New and Renewable Energy (MNRE) from 1 October 2011. A career civil servant with over 34 years of experience, both at the national and state level, Shri Pradhan joined the Indian Administrative Service (IAS) in 1977. He joined the Ministry of Power, as Joint Secretary, in November 2003 where he handled diverse subjects like energy efficiency, transmission and operation maintenance. Shri Pradhan was promoted as Special Secretary in the Ministry of Power from 1 February 2011 and has been actively involved in the Jawaharlal Nehru National Solar Mission (JNNSM). He is the Chairman of the Committee set up by MNRE, to draft Guidelines for Selection of New Grid Connected Solar Power Projects. Akshay Urja welcomes Shri Pradhan as its new patron.

Tamil Nadu seeks help to use wind power

The Tamil Nadu government has sought the help of private players to set up infrastructure for wind power evacuation in the State. The government is looking at setting up 230 KV to 400 KV substations to carry the power from generation points to distribution centres. Speaking at a seminar on Sustainable Energy for Economic Growth organised by the Southern India Chamber of Commerce and Industry, the State Power Minister Natham R Viswanathan said that the State's wind generation capacity was 6067 MW. Of this, nearly 300 MW is not used due to evacuation problems.

http://articles.timesofindia.indiatimes.com, 27 August 2011

Karnataka plans land use policy for wind energy

The Karnataka government would soon bring out an exclusive land policy for allotment of land for wind energy projects. The policy will be modelled on Gujarat's policy and will be announced in the next two to three months, said an official. "There are several wind energy developers waiting for the allotment of land in the state. Many projects in the Western Ghats area are waiting to be completed. The government is taking some strict measures to retain only the serious players in the business of installing wind power projects," N S Prasanna Kumar, Managing Director, Karnataka Renewable Energy Development Ltd (KREDL) said. A survey is presently going on to assess the need for upgrading wind energy projects. The turbines need to be replaced with the latest technology, he said. Of an estimated potential of 23585 MW in the renewable energy sector, the Karnataka government has so far allotted projects for a capacity of 14391 MW, Kumar added.

www.business-standard.com, 26 August 2011

India announces solar PV power bidding for 350 MW

India announced its Request for Selection (RfS) Document for 350 MW of solar under Phase I, Part II of JNNSM. Project capacity shall be at least 5 MW (with a tolerance of + 5 per cent) in case of solar PV projects and the maximum capacity of the project shall be up to 20 MW (with a tolerance of ± 5 per cent). The plant capacity shall remain in multiples of 5 MW. There is more flexibility for smaller and larger players to participate as per their investment plan.

www.pv-magazine.com, 26 August 2011

Investment in wind energy sector

A wind power capacity of 565 MW has been installed in the country in the current year (up to July 2011) with private sector investment of around Rs 3,400 crore. The Government is promoting wind power projects through private sector investment by providing fiscal and promotional incentives such as 80 per cent accelerated depreciation, concessional import duty on certain components of wind electric generators and excise duty exemption to manufacturers. A 10 years tax holiday on income generated from wind power projects is also available. Loans for installing windmills are available from Indian Renewable Energy Development Agency (IREDA) and other Financial Institutions while technical support including wind resource assessment is provided by the Centre for Wind Energy Technology (C-WET), Chennai.

http:*//pib.nic.in, 26 August 2011*

India is a favoured investment destination in Clean Energy

An investment of about Rs 4,900 crore has been received as foreign direct investment (FDI) equity inflows in the renewable energy sector during the last three years including the current year. A recent report by independent consultants E&Y (Ernst & Young Renewable Energy Country Attractiveness Indices, May 2011) has ranked India as the 3rd best investment destination in renewable energy sector, next only to China and USA.

http://pib.nic.in, 26 August 2011

EoI for Sunderban project

The West Bengal Government said that it has invited an expression of interest (EoI) from private sector companies to partner West Bengal Green Energy Development Corporation for implementation of the country's largest renewable energy project in the

Sunderbans. The biomass-solar hybrid project is planned for execution under a public private partnership model and the project cost is pegged at Rs 110 crore.

The project falls under the Centre's Gramin Vidyutikaran Yojana (rural electrification scheme) and as such, the Ministry of Power has sanctioned a grant for implementation of the project, while the remaining amount would be borne by the project partners. The project would use both biomass and solar sources to provide round-the-clock power supply. The project would be developed under a viability gap funding model, based on which the end-product has to be sold at a specified price.

www.thehindubusinessline.com,
25 August 2011

IIM-A, MNRE and DST launch fund for start-ups in sustainable energy

In an effort to support aspiring entrepreneurs in the sustainable energy sector, the Indian Institute of Management, Ahmedabad (IIM-A) is set to launch a fund on sustainable energy in the sector. The initiative titled 'Indian Fund for Sustainable Energy (INFUSE)', is a collaborative partnership between the private-public-academia to build sustainable energy ventures for India. The fund is partnered by IIM-A, Ministry of New and Renewable Energy (MNRE), British Petroleum (BP), Technology Development Board (TDB), and Department of Science and Technology (DST).

While the Centre for Innovation, Incubation and Entrepreneurship (CIIE) at IIM-A will work as the implementing agency, IIM-A would function as the nodal agency for the same. "We are planning to raise around Rs 100 crore in the next 3 years through more corporate participation in the fund. We would be focusing on young enterprises, start-ups and innovative business models who work with the existing renewable energy technologies. Once we have more capital, we would be able to give start-ups in this domain anything between Rs 2-2.5 crore and more as capital depending on the project. This would help fill the gap between seed funding and private equity players for an upcoming enterprise," said Rakesh Basant, Chairperson of CIIE at IIM-A. According to Shri Basant, the scope of the initiative is to facilitate clean energy technology projects in different spaces.

www.business-standard.com,
24 August 2011

SEMI India launches solar PV technical training programmes

SEMI India, the Indian arm of the global industry organisation, Semiconductor Equipment and Materials International (SEMI), launched a solar PV work force development initiative, with a three day short course on "Solar PV Power Systems: Concepts, Operation and Applications" in Jaipur, Rajasthan. Workforce development was identified as a priority action area for 2011 by SEMI India's PV Advisory Committee, comprising key executives from India's solar PV industry. The short course in Jaipur will be the first in a series of courses that SEMI will organise, in technical collaboration with NCPRE (the National Centre for Photovoltaic Research and Education, IIT Bombay) and offer in different centres across the country.

SEMI India's workforce development initiative aims to address the needs of SEMI member companies and of the wider solar PV industry in India by offering high quality training programmes delivered by leading academic and industry experts and expanding awareness about state of the art solar/PV technologies, applications and practices among engineers and technical personnel.

Estimates suggest that this industry will need more than 10,000 technicians in the next 5 years as well as skilled engineers in various aspects of solar/PV technology and manufacturing. Some of the world's top thin film and crystalline technology companies are emphasising their activities in India and leading Indian and global manufacturers have unveiled aggressive expansion plans for the Indian market.

www.indiainfoline.com,
24 August 2011

Djibouti asks for assistance from India to harness its renewable energy sources

Dr Fouad Ahmed Aye, Minister of Energy, Water and Natural Resources, Republic of Djibouti

held bilateral discussions with Dr Farooq Abdullah, Minister of New and Renewable Energy in New Delhi. Both the leaders held detailed discussions about possible cooperation between the two countries in the field of Renewable Energy.

Dr Fouad Ahmed Aye informed that Djibouti has vast potential in the areas of geothermal energy, solar energy and wind energy but needs Indian assistance in exploiting these sources. He expressed desire to sign a Memorandum of Understanding (MoU) between the two countries in this regard. Dr Farooq Abdullah welcomed the suggestion and suggested that in the first instance, a team of Indian experts can visit Djibouti to ascertain specific requirements of that country and after that, a MoU can be worked out between the two countries. The Minister from Djibouti also requested for Indian assistance in providing training to their nationals in drilling to harness Geothermal Energy. Dr. Abdullah assured him of all possible assistance.

http://pib.nic.in, 23 August 2011

India to prepare a national bio-energy mission to boost power generation from biomass

The government is preparing a national bio-energy mission to boost power generation from biomass, a renewable energy source abundantly available in India. The mission, to be launched during the 12th Five-Year Plan, will offer a policy and regulatory environment to facilitate large scale capital investments in biomass-fired power stations, Minister of New and Renewable Energy, Dr Farooq Abdullah said. It will also encourage development of rural enterprises. "Our surplus biomass is estimated to be 150 million tonnes," he added on the sidelines of an event. "This could potentially be used to generate 16 GW of power."

http://articles.economictimes.indiatimes.com, 22 August 2011

SG Biofuels to develop jatropha hybrid for Bharat

California-based SG Biofuels (SGB) is to develop and deploy elite hybrids of jatropha for use as biodiesel feedstock in India. SGB will be developing the strains for Bharat Renewable Energy Ltd (BREL), a joint venture of Bharat Petroleum.

"Our project with Bharat is aimed at developing high performance hybrid material that is adapted to growing conditions in India," said Brian Brokowski, SGB's vice president of communications. "We will use our genetic library and our genetic material and our variety of hybrids... to work with Bharat to develop, select and test the best performing hybrid varieties."

www.biodieselmagazine.com, 10 August 2011

Financial closure of solar power projects

36 project developers who had signed Power Purchase Agreement (PPA) with NTPC Vidyut Vyapar Nigam (NVVN) for setting up of 615 MW capacity of grid power projects under the Jawaharlal Nehru National Solar Mission (JNNSM), in January 2011 have reported financial closure by the due date of 9 July 2011. The project developers were required to achieve financial closure in six months from the date of signing PPA. NVVN has accepted the documents of financial closure of 35 project developers for setting up of 610 MW capacity. One project for 5 MW capacity has failed to meet the requirements.

http://pib.nic.in, 8 August 2011

Akshay Urja bids adieu to Shri Deepak Gupta

Secretary to the Government of India since 1 July 2008, Shri Deepak Gupta belonged to Jharkhand Cadre 1974 batch of the Indian Administrative Service (IAS). After doing several District level assignments in Bihar, he came to the Government of India in 1981 as Deputy Jute Commissioner, Ministry of Textiles. He became Additional Secretary, Ministry of Health & Family Welfare in September 2005 and was subsequently promoted to Special Secretary in January 2008 in the same Ministry. Shri Deepak Gupta was Secretary to the Government of India in the Ministry of New and Renewable Energy (MNRE) from July 2008 to September 2011.

The major initiatives taken by Shri Gupta include launch of JNNSM, DIREC 2010, green buildings, energy access to rural areas, preparation of Bio-energy Mission, cook stoves etc. Akshay Urja bids adieu to Shri Deepak Gupta.

Italy to overtake Germany as largest solar PV market

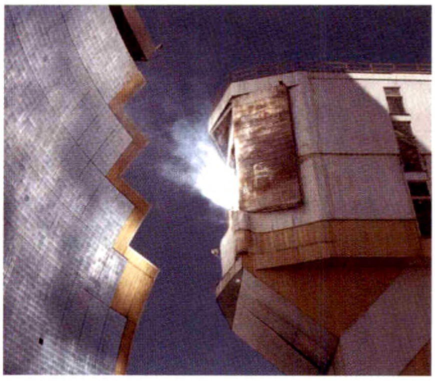
The Italian market for solar photovoltaic (PV) is set to become the largest in the world, after the country installed three times the volume of the current global leader, Germany, in the first half of the year, according to a report from SolarPlaza. In 2010, Italy installed 2319000 kW of solar power, supported by a feed-in tariff, which provides financial incentives for consumers and business customers who install a solar power system, says the report. The biggest market in the world in 2010 was Germany, which accounted for 50 per cent of the global market in 2010. The country installed almost eight GW of new solar PV power and, in one year, 40 m solar panels covered 50 m sq m.

The other countries in the top ten were the Czech Republic (1151000 kW of solar PV power installed in 2010), Japan (990979 kW), the US (918000 kW), France (719000 kW), China (400000 kW), Spain (392000 kW), Australia (383300 kW) and Belgium (357860 kW). China and India are set to become major players. India has introduced the National Solar Mission and China recently announced its own feed-in tariff system. Other new markets that will become more prominent are the Philippines, Israel, Canada and South Africa.

www.europeanplasticsnews.com, 25 August 2011

Solar Furnaces: a powerful use of solar power

Solar power can be used in many extraordinary ways. One of the most majestic applications of solar thermal energy is the solar furnace. These are enormous installations that make use of solar thermal energy for extreme high heat processes (temperatures as high as 3500°C/6330°F). The technology is suitable for high temperature research; the heat produced is very clean with no pollutants. There are a variety of uses for this energy, such as hydrogen fuel production, foundry applications and high temperature materials testing. Thus, science can advance without enormous energy bills. Research can take place in areas previously deemed too costly or polluting to be worthwhile.



The largest solar furnace currently in existence is at Odeillo in the Pyrenees-Orientales in France; it has been operational since 1970. This area boasts extremely high air quality and approximately 300 days of sunlight a year, making it a perfect spot for a solar furnace. This is also the same area in which the first solar furnace was built; this solar furnace was put in place at Mont-Louis in 1949 by Professor Felix Trombe. Odeillo and Mont-Louis are within 15 km of each other.

The furnace makes use of a large parabolic reflector concentrating the sun into an area the size of the common cooking pot. The reflector is discrete; 63 individual flat mirrors track the sun in unison and redirect the solar thermal energy towards the crucible.

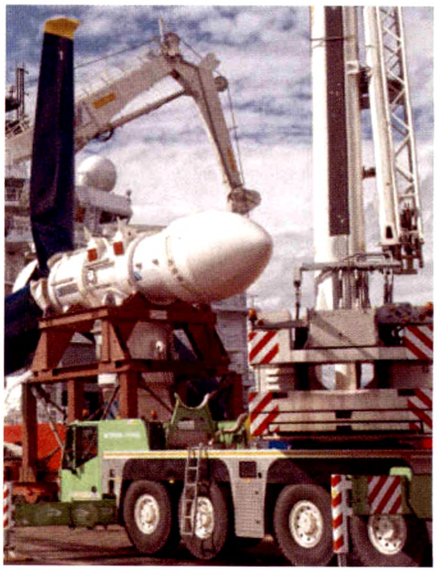
http://also.kottke.org, 25 August 2011

Atlantis Resources hooks up 1 MW tidal turbine to Scottish grid

Marine renewables developer Atlantis Resources has wired in its 1 MW AR1000 tidal-power turbine at the European Marine Energy Centre (Emec) in Orkney, Scotland. The three-bladed horizontal axis machine becomes Scotland's first commercial-scale tidal device to be grid connected.

With its 18 m diameter rotor, the AR1000 is designed to be among the world's most powerful single-rotor tidal turbines, rated to dispatch 1 MW of predictable power in water velocities of 2.65 m per sec. Weighing 1,500 tonnes, 22.5 m tall and set on a seabed-mounted tripod foundation, the machine is a rejigged version of the company's twin-headed AK1000 system. The earlier device had to be pulled from the water last year after a manufacturing flaw in its experimental hybrid rotor resulted in delamination of the blades. A review conducted during the wait for replacement blades led Atlantis to opt to deploy the nacelle in a pared-down, single-rotor configuration.

www.rechargenews.com, 12 August 2011



UN Secretary General stresses role of renewables in delivering electricity

UN UN Secretary General Ban Ki-moon stated that providing clean renewable energy to the 1.4 billion people living without electricity is a top priority for the United Nations, during a visit to the US Department of Energy's National Renewable Energy Laboratories (NREL). The Secretary General further outlined three UN goals for 2030: ensuring universal access to modern energy services, doubling energy efficiency and doubling the renewable energy share in the overall global energy mix.

"When we put a priority on renewable energy we address job creation, we address climate change, women's empowerment and food security," said Ban. "Sustainable energy cuts across nearly every major challenge we face today and will face in the future."

www.solarserver.com, 24 August 2011

North Sea can host 135 GW wind capacity

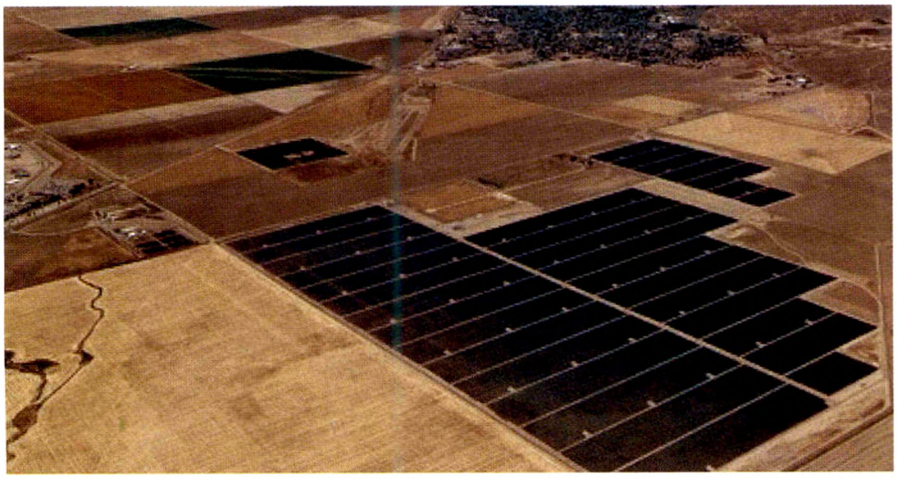
The North Sea could become home to offshore wind farms with a combined generating capacity as high as 135 GW by 2030, as per a study conducted as part of an international project chaired by the Energy Research Centre of the Netherlands. Belgium, Denmark, The Netherlands, Norway and the UK have coastlines around the North Sea. The study was undertaken by Windspeed, an offshore wind energy consulting firm.

www.financialexpress.com, 22 August 2011

Biggest solar PV plant in California revs up

California's largest functioning photovoltaic (PV) solar power plant, the 45 MW Avenal Solar Generating Facility on the western flank of the San Joaquin Valley has begun commercial operations. It is said to be producing enough power to keep the lights, air conditioners, big-screen TVs and refrigerators humming in 36,000 homes. The Avenal plant, about 75 miles north of Bakersfield in Kings County, comprises three projects: Avenal Park (6 MW), Sun City (20 MW) and Sand Drag (19 MW).

www.earthtechling.com, 18 August 2011



Solar panels keep buildings cool

Solar panels on top of a roof do not just provide clean power; they cool the house, or workplace, too, according to a team of researchers led by Jan Kleissl, a professor of environmental engineering at the University of California, San Diego (UCSD) Jacobs School of Engineering.

In a study in an upcoming issue of the journal *Solar Energy*, Kleissl and his team published what they believe are the first peer-reviewed measurements of the cooling benefits provided by solar photovoltaic (PV) panels. Using thermal imaging, researchers determined that during the day, a building's ceiling was 5°F cooler under solar panels than under an exposed roof. At night, the panels help hold heat in, reducing heating costs in the winter.

www.sciencedaily.com, 20 July 2011

First Solar sets world record for CdTe solar PV efficiency

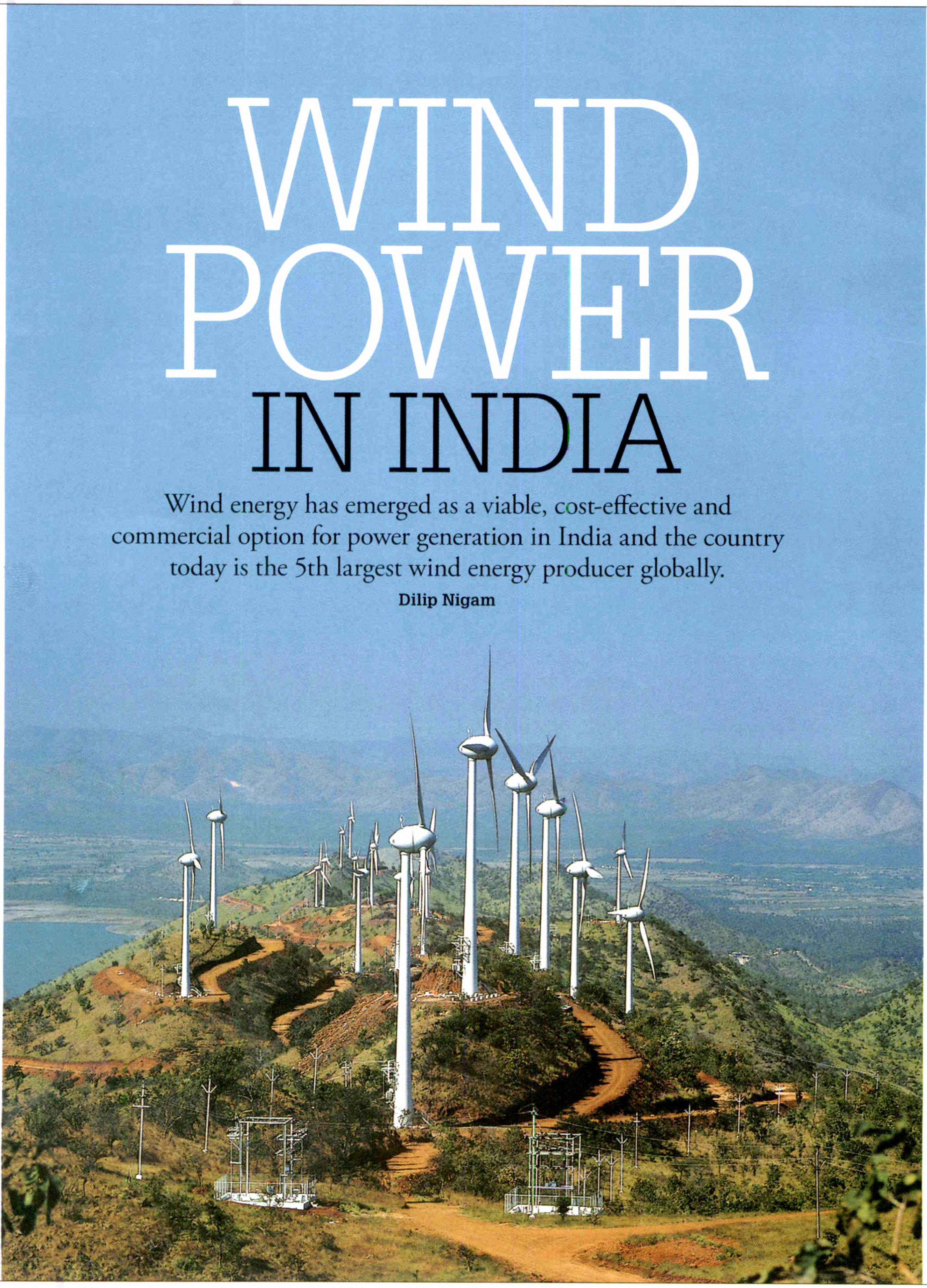
First Solar has set a new world record for cadmium-telluride (CdTe) photovoltaic (PV) solar cell efficiency, reaching 17.3 per cent with a test cell constructed using commercial-scale manufacturing equipment and materials. The test cell's performance, confirmed by the US Department of Energy's National Renewable Energy Lab (NREL), far surpassed the previous record of 16.7 per cent set in 2001.

www.globalsolartechnology.com, 1 August 2011

WIND POWER IN INDIA

Wind energy has emerged as a viable, cost-effective and commercial option for power generation in India and the country today is the 5th largest wind energy producer globally.

Dilip Nigam



Energy is the key to development and sustenance of a modern economy. It is a critical infrastructure on which the socio-economic development of the country depends. The demand for power has grown rapidly and today we find it difficult to match demand and supply. India faces a formidable challenge in meeting its energy needs and providing adequate and affordable energy to all sections of society in a sustainable manner. The solution to this challenge lies in maximising the utilisation of RE sources for meeting our energy demands.

Amongst various RE options, wind energy has emerged as a viable, cost-effective and commercial option for grid connected power generation. During the past quarter of a century, a significant thrust has been given to the development, trial and induction of wind energy technology for use in different sectors. The country is today the 5th largest wind energy producer globally after China, US, Germany, and Spain. However, we have a long way to go to harness the vast potential we have. Wind has made a significant contribution to the installed capacity of power generation and has emerged as a competitive option to fossil fuel based power generation. This is due to the multidimensional initiatives taken by the Ministry of New and Renewable Energy (MNRE) through the Wind Power Programme, which aims at large scale commercialisation of cost effective generation of grid quality wind power. The Wind Power Programme includes comprehensive wind resource assessment programme; research and development; implementation of demonstration projects to create awareness; development of infrastructural capability; capacity of manufacture, installation, operation and maintenance of wind turbines and conducive policy formulation. An important role played by the Ministry has been towards introduction of suitable fiscal and promotional incentives at the central and state levels to encourage private investors and developers to take up commercial projects.

Wind Resource Assessment

The wind climatology in our country is mainly governed by the monsoon circulations. Winds in India are influenced by the strong southwest summer monsoon, which starts in May-June, when cool, humid air moves towards the land and the weaker northeast winter monsoon, which starts in October, when cool, dry air moves towards the ocean. Wind energy is intermittent and highly site-specific and therefore, an extensive wind resource rssessment programme is essential for deciding the potential sites. That is why from the beginning the Ministry placed an emphasis on wind resource rssessment and today India has abundant data, collected from about 1100 wind masts in 32 states and union territories (UTs). Presently, the Wind Resource Assessment Programme is being implemented in the country through the Centre for Wind Energy Technology (C-WET), an autonomous institution of the Ministry and associated State Nodal Agencies (SNAs).

> **Wind energy is intermittent and highly site-specific and therefore, an extensive Wind Resource Assessment Programme is essential for deciding the potential sites.**

The locations having annual mean wind power density greater than 200 W per sq m at 50 m height were considered suitable for commercial wind power development and a total of 233 such wind monitoring stations, covering sites in 14 States/

Table 1. State-wise wind power potential

States/UTs	Installable Potential (MW)
Andhra Pradesh	5394
Gujarat	10609
Karnataka	8591
Kerala	790
Madhya Pradesh	920
Maharashtra	5439
Rajasthan	5005
Tamil Nadu	5374
West Bengal*	22
Orissa	910
Andaman & Nicobar	2
Arunachal Pradesh*	201
Assam*	53
Chhattisgarh*	23
Himachal Pradesh*	20
Jammu & Kashmir*	5311
Lakshadweep	16
Manipur*	7
Meghalaya*	44
Nagaland*	3
Sikkim*	98
Uttarakhand*	161
Uttar Pradesh*	137
Total	**49130**

*Wind potential has yet to be validated with measurements

> **All the major global players in this field have their presence in the country and the unit size of machines has gone up to 2.50 MW.**

UTs, were identified as potential sites. However, recently the Ministry has removed the requirement of a threshold power density for suitability of sites for wind power projects so that new innovative machines suitable for low wind regimes could be developed. Seven volumes of the Handbooks on 'Wind Energy Resource Survey in India' have so far been published covering wind data for 234 sites in 13 states/UTs. C-WET has published a wind atlas for India and the wind power potential of the country has been estimated to be 49130 MW assuming 2 per cent of the land availability for wind power generation in the potential areas except for Himalayan/North Eastern states and Andaman and Nicobar islands. State wise wind potential is given at Table 1.

Demonstration Wind Power Projects

The demonstration wind power projects were taken up by the Ministry during early years with the basic objective to create necessary infrastructure to open up the sites for commercial development by demonstrating the success so that private sector gets confidence to invest. The first demonstration project in the country was set up near Tuticorin in Tamil Nadu in the year 1986. Subsequently, an aggregate demonstration project capacity of 71 MW was established at 33 locations in 9 States (Table 2). Most of potential sites have been demonstrated and it has led to commercial development. These projects have helped private investors in analysing the performance and economics of wind power projects and identifying areas of concern in the operation of wind based power projects.

Commercial Development

Technology Development and Manufacturing Base

The Wind Electric Generators (WEG) technology has evolved very rapidly in the country. State-of-the-art technologies are now available for the manufacture of wind turbines. All the major global players in this field have their presence in the country. The unit size of machines has gone up to 2.50 MW. Wind turbines are being manufactured by 18 manufacturers in the country, through (i) joint ventures under licensed production; (ii) subsidiaries of foreign companies, under licensed production; and (iii) Indian companies with their own technology. The current annual production capacity of domestic wind turbines is about 3000 MW, which can be easily expanded to 5000 MW, if market demands. Total 41

Table 2: State wise list of demonstration wind power projects

State	Demonstration Projects (MW)
Andhra Pradesh	5.4
Gujarat	17.3
Karnataka	7.1
Kerala	2.0
Madhya Pradesh	0.6
Maharashtra	8.4
Rajasthan	6.4
Tamil Nadu	19.4
West Bengal	1.1
Others	3.3
Total	71.0

Source: MNRE

different models of wind turbines of unit size from 250 kW to 2.50 MW are being manufactured in the country.

Efforts are being made to develop the technology towards better aerodynamic design; use of lighter and larger blades; higher towers; direct drive; and, variable speed gearless operation using advanced power electronics. The recent one is Permanent Magnet technology. India, in general, has low wind regimes, therefore, we need to develop and promote technology suitable for our wind climatology. The technology is continuously upgrading, keeping in view global developments in this area. Wind turbines and wind turbine components are also being exported to the US, Australia, Europe, Brazil and Asian countries. Due to a strong domestic manufacturing base, some companies abroad now source many components for their turbines from India. This has resulted both in more cost-effective production and in creating additional local employment.

Deployment

Over the last decade, significant progress has been made in harnessing wind for power generation in different parts of the country. The successful operation of the demonstration projects attracted large investors towards wind. The first wind farm in the private sector was set up in Tamil Nadu and the energy was wheeled to the developers industry for captive use. Other states like Gujarat and Andhra Pradesh adopted the Tamil Nadu model. The annual growth picked up from the start of 2002. The bulk of the addition is in Tamil Nadu. A total wind power capacity of over 15000 MW has been established up to August 2011 mainly in Tamil Nadu, Gujarat, Maharashtra, Andhra Pradesh, Karnataka and Rajasthan. Tamil Nadu alone has an installed capacity of over 6000 MW. The year 2010-11 was a good year when country witnessed a capacity addition of 250 MW and first time in the country, annual installations crossed the figure of 2000 MW. The wind power capacity contributes to about 8.5 per cent of the total grid connected installed power capacity in the country. Large scale commercial developments, all with private sector investments are currently taking place in the states of Tamil Nadu, Rajasthan, Maharashtra, Karnataka, and Gujarat. These projects so far have generated around 100 billion units of electricity in the country.

Infrastructure for Power Evacuation and Transmission

With rapid growth of wind power sector in last few years, utilities need to plan for timely creation of power evacuation and transmission facilities. States like Tami Nadu are finding it very difficult to meet the requirments. They require funds to the order of few thousand crores. The Ministry is trying to support them financially through National Clean Energy Fund (NCEF). We also need to facilitate inter-state transmission of wind power. As most states are energy deficient, they are reluctant to transmit the wind power to other states.

New Initiatives

Wind Atlas

Most countries having wind power development have a Wind Atlas. The development in India was, so far, dependent upon the field measurements. A numerical Wind Atlas for India has been prepared and launched, which will help the stake-holders in getting better micro siting leading to higher generation from wind power projects. The Wind Atlas has been prepared by C-WET in association with the Riso National Laboratory, Denmark. The modelling techniques used for preparation of Wind Atlas for India include WasP and KAMM. The vast field wind data obtained under wind monitoring programme is being used for validation of the Atlas.

Generation Based Incentive Scheme

The main driving force until 2009 for development of wind sector has been the provision of accelerated depreciation of 80 per cent. This provision has enabled large profit making companies, small investor and captive users to participate in the sector. However, in the last few years, the power scenario in India has witnessed a qualitative change with the entry of Independent Power Producers (IPPs) and Foreign Direct Investors (FDIs), who cannot avail of the accelerated depreciation provision. Therefore, in order to broaden the investor base, and encourage better generation efficiencies, the Ministry introduced a Generation Based Incentive (GBI) of 50 paise per unit for such class of investors. The scheme was launched in December 2009. The response to the scheme is modest and around 800 MW wind power projects have been installed under the scheme.

Renewable Energy Certificates

A new system of Renewable Energy Certificates (RECs) has been introduced in the country, by which energy generated and fed to the grid will entitle the developers to trade the RECs issued to them. The system has been recently operationalised, however, it has not responded so well in the beginning. It is expected that with time the REC mechanism will further enhance the growth.

Global Scenario

Wind energy has emerged world-wide into a mature and booming global business. Generation costs have fallen over

Table 3: Policies introduced by the state governments for wind power projects (as on June 2011)

	Wheeling and Transmission	Banking	Buy-back	Open access transaction	Renewable Purchase Obligation (RPO)
Andhra Pradesh*	As per rules, regulations and terms and conditions as approved by the Commission.	Allowed	Rs 3.50 per unit frozen for 10 years	Allowed	5.0 per cent
Haryana*	2 per cent of energy	Allowed for 1 year	Rs 4.08 per unit escalation 1.5 per cent base year 07-08	Allowed	09.10 - 10.00 per cent
Karnataka*	5 per cent of energy	Allowed @ 2 per cent of energy input	Rs 3.70 per unit Fixed for 10 years	Allowed	7 per cent - 10 per cent Captive & Open Access -5 per cent
West Bengal	1/3 of the wheeling charges calculated as per tariff order under Tariff Regulations or cost of 7.5 per cent of the energy fed to the grid irrespective of the distance of wheeling, whichever is higher and transmission charges will be two-third of the rate of such charges applicable for open access customers for long term and short term open access.	6 Months	To be decided on case to case basis with a cap of Rs 4.87 per unit	Allowed	10-11 - 2.00 per cent 11-12 - 3.00 per cent 12-13 - 4.00 per cent
Madhya Pradesh*	Allowed 2 per cent of energy + transmission charges as per Electricity Regulatory Commission (ERC)	Allowed	Rs. 4.35 per unit Fixed for entire project life	Allowed	10-11- 0.80 per cent 11-12- 2.50 per cent 12-13- 4.00 per cent 13-14- 5.50 per cent 14-15- 7.00 per cent
Maharashtra*	As per Open Access Regulations	12 Months	#	Allowed	10-11- 6.00 per cent 11-12- 7.00 per cent 12-13- 8.00 per cent 13-14- 9.00 per cent 14-15- 9.00 per cent 15-16- 9.00 per cent
Rajasthan*	Transmission charges applicable to Renewable Energy Systems (RES) power stations be half (i.e. 50 per cent) of the transmission charges, specified by the Commission for open access consumer.	6 Months	Rs. 4.22 per unit for Jaisalmer, Barmer and Jodhpur etc. and Rs 4.44 per unit for other districts (for FY 2011-12)	Allowed	^
Tamil Nadu*	5 per cent of Energy in case of consumption at High Voltage (HV)/ Extra High Voltage (EHV) and 7.5 per cent in case of Low Voltage (LV)	5 per cent (12 months)	Rs. 3.39 per kWh (Levelised)	Allowed	14.00 per cent
Gujarat*	Transmission charges and 4.40 per cent as transmission losses for 66 kV and above. Transmission Charges and 10.0 per cent as transmission losses and wheeling charges for below than 66 kV $$	Monthly settlement	Rs. 3.56 per unit	Allowed	10-11- 5.00 per cent 11-12- 6.00 per cent 12-13- 7.00 per cent
Kerala*	5 per cent of energy	9 Months (Jun.-Feb.)	Rs 3.64 per kWh	Allowed	3.00 per cent from 2010 with annual increase of 10 per cent of 3 per cent per year up to a max. RPO of 10 per cent
Punjab*	2 per cent	Allowed	Rs 3.66 per unit with five annual escalation @ 5 per cent up to 2012	Allowed	08-09 6.25 per cent 09-10 7.45 per cent 10-11 8.50 per cent 11-12 9.50 per cent
Orissa	On Actual basis	Allowed	Rs. 5.31 per unit	Allowed	@

*Policy announced by State Electricity Regulatory Commission in the respective State.

# The Tariff is as follows

Particular	Net Levellised Tariff (FY 2010-11)
Wind Zone – 1	4.56
Wind Zone – 2	3.96
Wind Zone – 3	3.38
Wind Zone – 4	3.04

The Interim Tariff applicable for the wind power projects in the State of Maharashtra commissioned during FY 2011-12 shall be the tariff determined for Wind Zone - 2

^ - As per the Amendment in its RERC (Renewable Energy Obligation) (1st Amendment) Regulations, 2011 and RERC (Power Purchase & Procurement Process of Distribution Licensee) (2nd Amendment) Regulations, 2011.

Financial Year	Obligation expressed as per cent of energy consumption			
	Wind	Biomass	Solar	Total
2011-12	4.50	1.00	0.50	6.00
2012-13	5.10	1.25	0.75	7.10
2013-14	5.70	1.25	1.00	8.20

$ - However, where distribution licensee network below 132 kV level is utilised, the wheeling charges (in cash) applicable to RES power stations, be 50 per cent of normal charges, as applicable & specified for 33 kV by the Commission, irrespective of the voltage at which electricity is supplied.

For direct supply to consumer on transmission system	4.4 per cent
For the supply using distribution network of distribution licensee below 132 kV	3.6 per cent (i.e. the losses applicable for 33 kV system)
For the supply using both EHV transmission & distribution system	8.00 per cent

$$ - ** - If Wind Electric Generators (WEGs) having only one WEG in the State, then applicable Open Access charges will be transmission charges and transmission and wheeling losses @ 7 per cent. Further, WEG's who desires to wheel electricity to more than two locations, shall pay 5 paise per unit on energy fed in the grid to the Distribution Company concerned in addition to the mentioned transmission charges and losses.

@ RPO for Orissa is as follows:

Year-wise target	Minimum quantum of purchase in percentage (in terms of energy consumption in the State in kWh)			
	Renewable		Co-generation	Total
	Solar	Non-solar		
2009-10 (Actual)	-	0.80	3.45	4.25
2010-11	-	1.0	3.50	4.5
2011-12	0.10	1.20	3.70	5.0
2012-13	0.15	1.40	3.95	5.5
2013-14	0.20	1.60	4.20	6.0
2014-15	0.25	1.80	4.45	6.5
2015-16	0.30	2.00	4.70	7.0

Table 4: Global Wind Power installed capacity

Country	Installed Capacity up to Dec. 2010
China	44,733
USA	40,180
Germany	27,214
Spain	20,676
India	13,065 (now 14,989)
Italy	5,797
France	5,660
UK	5,204
Canada	4,009
Denmark	3,752
Rest of world	26,749

Global Wind Report - Annual Market Update 2010, Global Wind Energy Council www.gwec.net

the last few years, moving competitive with conventional energy sources. The technology has improved dramatically in view of higher capacity machines, higher hub-heights and efficient and reliable technology. In view of concerns shown for global warming, there is a huge and growing global demand for the environment friendly wind power. Over the last decade, global wind installations have continued to grow at an average growth rate of around 30 per cent. The world witnessed the year 2010 to be another record year for the wind power development with more than 27000 MW of new installations, taking the cumulative installed capacity to 194000 MW. During 2010, China surpassed US to become the number one global market. Major contributing countries are China (44.73 GW), United States (40.18 GW), Germany (27.21 GW), Spain (20.67 GW), and India (13.06 GW) up to December 2010 (Table 4).

Guidelines for Setting up Projects

The Ministry has been issuing comprehensive guidelines for wind power projects to all concerned since July 1995 to bring about healthy and orderly growth of the wind energy sector and to achieve optimum generation of power in the most efficient and cost-effective manner. These guidelines relate to preparation of Detailed Project Reports (DPR), micro siting, selection of wind turbine equipment, operation and maintenance, performance evaluation, etc. These guidelines have created awareness in the State Electricity Boards, SNAs, manufacturers, developers and investors about planned development and implementation of wind power projects. The C-WET issues a list of manufacturers of certified wind turbines on a quarterly basis under different categories. The guidelines have helped in installation of quality wind turbines and an orderly growth in the country.

Fiscal Incentives and Promotional Policies

The Government promotes wind energy sector in the country through fiscal incentives such as 80 per cent accelerated depreciation in the first year, concessional custom duty on certain components of wind electric generators, excise duty exemption, ten years' tax holiday on income generated from wind power projects, and loan from Indian Renewable Energy Development Agency (IREDA) and other financial institutions. MNRE has been issuing guidelines to all State Governments to create an attractive environment for the purchase, wheeling and banking of electricity generated from wind power projects. The incentives were given to encourage industrial companies and businesses to invest in wind power. Preferential tariff is being provided to increase wind energy generation in the potential states. The states of Tamil Nadu, Andhra Pradesh, Haryana, Karnataka, Madhya Pradesh, Rajasthan, Maharashtra, Gujarat, Punjab, Kerala, Orissa and West Bengal have announced the preferential tariffs ranging from Rs. 3.39 to 5.00 per kWh. A total of 15 State Regulatory Commissions have announced the Renewable Power Obligations (RPOs), which mandates the Distributing Licensees to necessarily take up to 14 per cent of electricity from renewables, which has accelerated the growth. The policies announced by various states are given at Table 3. ✪

The author is Director, Ministry of New and Renewable Energy, New Delhi.

Understanding Wind Turbines

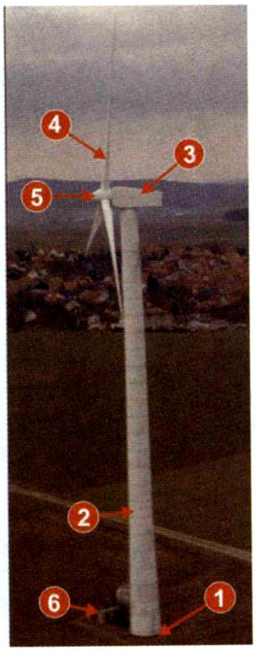
Tower and foundation

In order to guarantee the stability of a wind turbine a pile or flat foundation is used, depending on the consistency of the underlying ground. The tower construction does not just carry the weight of the nacelle and the rotor blades, but must also absorb the huge static load caused by the varying power of the wind. Generally, a tubular construction of concrete or steel is used. An alternative to this is the lattice tower form.

Examples of tower heights:

- hub height 40-65 m: approx. 600 rated power and approx. 40 to 65 m rotor diameter
- hub height 65 to 114 approx. 1.5 to 2 rated power and approx. 70 m rotor diameter
- hub height: 120 to 130 approx. 4.5 to 6 rated power and approx. 112 to 126 m rotor diameter

The foundation anchors the wind turbine to the ground.



1. Foundation
2. Tower
3. Nacelle
4. Rotor blade
5. Hub
6. Transformer (this is not a part of the Wind Turbine)

Rotor and rotor blades

The rotor is the component, which, with the help of the rotor blades, converts the energy in the wind into rotary mechanical movement. Currently, the three-blade, horizontal axis rotor dominates. The rotor blades are mainly made of glass fibre or carbon fibre reinforced plastics, also called glass reinforced plastic (GRP) or carbon fibre reinforced plastic (CFRP). The blade profile is similar to that of an aeroplane wing. They use the same principle of lift: on the lower side of the wing the passing air generates higher pressure, while the upper side generates a pull. These forces cause the rotor to move forwards, i.e. to rotate.

Nacelle with drive train

The nacelle holds all the turbine machinery. Because it must be able to rotate to follow the wind direction, it is connected to the tower via bearings. The buildup of the nacelle shows how the manufacturer has decided to position the drive train components (rotor shaft with bearings, transmission, generator, coupling and brake) above this machine bearing.

Gearbox

The gearbox converts the rotor motion of 18-50 revolutions per minute (rpm) into the approx. 1,500 rpm, which the generator requires. The gearbox thus takes on the task of matching the rotation speeds of the slow moving rotor and the fast moving generator, and generally has several steps to cover for various wind conditions. If a specially developed multi pole ring generator is used, the gearbox is no longer required.

Generator

For high power wind turbines, doubly fed asynchronous generators are most frequently used. Here, the operating rotation speed can be varied somewhat, unlike when using conventional asynchronous generators. Another concept uses synchronous generators. A grid connection of synchronous generators is only possible via transformers, due to the fixed rotation behaviour. The disadvantage of requiring complicated control systems is countered by the overall efficiency and better grid compatibility.

Coupling and brake

Because of the enormous torque, the coupling between the main shaft and the transmission is a rigid one. The type of brake depends on the control mechanism for the blades.

Electronic equipment

The electronic equipment of a wind turbine is composed of the generator, the system for the grid infeed of the electricity, and various sensors. The sensors for measuring temperature, wind direction, wind speed and many other things can be found in and around the nacelle, and assist in turbine control and monitoring.

Other components

Finally, the wind turbine contains components for following the wind direction, for cooling, heating and lightning protection, as well as lifting gear (e.g. winches for spare parts) and fire extinguishing equipment. ✪

5th Renewable Energy India 2011 Expo

Held on 10-12 August 2011 at Pragati Maidan, New Delhi, the event has evolved from a niche solar event held in 2007 to a global RE event.

The 5th Renewable Energy India Expo served as an excellent medium for technology transfer into the Indian renewable energy (RE) industry. Some of the technologies showcased at the expo were on display for the very first time in India. Addressing the delegates during the inauguration, Shri Deepak Gupta, Secretary, Ministry of New and Renewable Energy (MNRE), said, “For the first time ever, we have exceeded capacity additions of more than 3000 MW a year for renewable energy. In India, the current installed capacity from renewable sources constitutes 11.5 per cent of the total power generation, a sizeable increase from the 3 per cent recorded in 2003”. Speaking further, he remarked, “Wind will continue to be the main driver of RE in India; we are targeting 4000 MW of capacity additions a year from the current benchmark of 2000 MW a year”.

The expo brought together leading international and domestic players, policy makers and technocrats on a common platform. With 527 exhibitors from 33 countries, the event has evolved from a niche solar event held in 2007 to a global RE event. Country pavilions from Belgium, Canada and Korea, and large contingents of trade delegations made an impressionable international presence at the expo.

The concurrent conference sessions comprised of interesting workshops, interactive panel discussions and engaging conference sessions. On the final day, there were intense deliberations on mainstreaming renewables in rural India with off grid solar photovoltaic (PV) technology.

While attending the event, Dr Farooq Abdullah, Hon’ble Minister of New and Renewable Energy, Government of India interacted with the participants and viewed the various technologies and products on display. The expo has served as an important gateway for worldwide new energy companies to access the Indian market and forge partnerships and collaborations with local players. The expo also highlighted diverse technologies ranging from high end to low end cost. ✪

National Meet on Solar Cities

A Solar City aims to reduce 10 per cent of demand of conventional energy of the city through a combination of enhancing supply from renewable energy and taking energy efficiency measures at city level.

SCOPE
सौर शहरों पर राष्ट्रीय बैठक
onal Meet on Solar Cities

Development of Solar Cities Programme of Ministry of New and Renewable Energy (MNRE) has a goal to promote the use of renewable energy (RE) in urban areas with active involvement of Municipal Corporations and various stakeholders. A comprehensive Master Plan of the City is prepared and a Solar City Cell is created in the city. It aims to reduce atleast 10 per cent of conventional energy demand of the city through a combination of renewable energy applications and energy efficiency measures.

60 Solar Cities/towns are being developed with 4 of these as Model Solar Cities. The Ministry has accorded sanctions to 37 Cities where the Master Plans are being prepared by expert Consultants.

A National Meet to review the progress of the implementation of the Scheme, particularly preparation of Master Plans and installation of projects was held under the chairmanship of Shri Deepak Gupta, Secretary, MNRE on 17 August 2011, in New Delhi. Dr Bibek Bandyopadhyay, Advisor, MNRE welcomed the guests and participants and gave a brief about the developments in the Solar City Programme.

Dr Ajay Mathur, Director General, Bureau of Energy Efficiency (BEE) said that it is imperative to develop eco friendly green cities, reduce energy consumption in the cities and adopt energy efficiency measures along with RE applications as these will decrease the total energy demand of a city. Shri Deepak Gupta, while appreciating the efforts of some of the municipal corporations emphasised that the pace of implementation of the Solar City Programme needs to be expedited. He clarified that under Solar City Programme not only solar related systems but also all RE projects and systems can be installed.

Dr A K Tripathi, Director, MNRE made a brief presentation on the status of the Solar Cities Programme and the various points/issues to be covered by the consultants while preparing the Master Plan.

Shri Tarun Kapoor, Joint Secretary, MNRE reviewed the progress of each city with the representatives of the municipal morporations and state nodal agencies (SNAs) and said that the Master Plan should be a comprehensive document. He emphasised that the data presented by the Consultant should be authentic, duly verified and properly referenced. ✪

developments and trends in wind technology

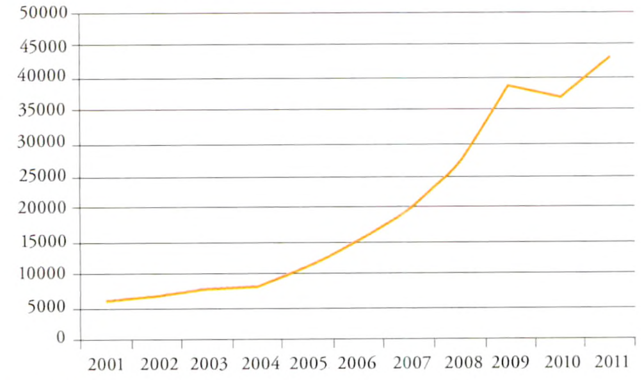
While enabling addition of generation capacity in an environmentally and economically sustainable manner, a major trend in wind turbine technologies, observed consistently since early eighties, is to build larger and larger wind turbines.

Jami Hossain

Someone has said that for every idea there is a time. It seems for the idea of wind, the time has come. Over the last 10 years, wind technology deployment has reached that crucial size, which would enable the technology to leap frog in terms of: worldwide onshore and offshore installations, customisation to regional markets, investments in research and development (R&D), wind potential assessments, regulatory frameworks, bankability, financing.... The trend is clearly towards the establishment of major renewable energy (RE) networks and infrastructure across the world.

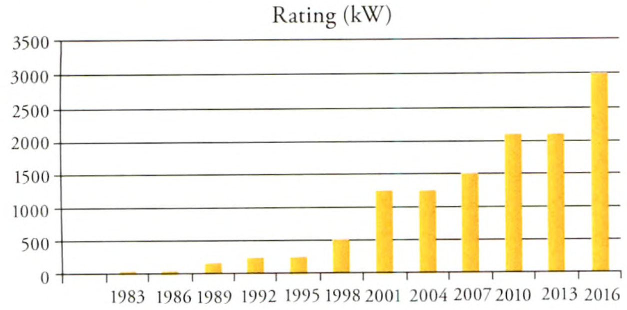
According to the World Wind Energy Association

Fig. 1. Worldwide trend in wind power installations (MW)



Source: World Wind Energy Association

Fig 2. Trends in ratings of WTG installations in India (MW)



(WWEA), nearly 215 GW wind power has been installed worldwide as on 30 June 2011. WWEA projects that by the end of 2011, across the world 240 GW of wind farms capacity would have been set up. Of the present 215 GW wind power capacity installed, 91 per cent capacity addition has happened 2001 onwards. Fig. 1 shows worldwide incremental installations till June 2011.

Potential for Utilisation of Wind Energy

For policy makers in the national and global arena, in order to come up with suitable policies and regulatory frameworks for wind energy or for that matter any other energy source, it is important to have clarity on the extent to which that source can be used to meet the energy needs. In other words, the potential for utilisation of that source.

A number of studies have been carried out and a very significant effort is being made in this direction. Cristina L Archer and Mark Z Jacobson of Stanford University in their 2001 report *Evaluation of Global Wind Power* assessed global wind power potential at 72 TW. While Xi Lu et al in their article *Global Potential for Wind Generated Electricity*, in the *Proceedings of the National Academy of Sciences* of the United States of America, in July 2009 estimated the worldwide potential at 2470 exajoules per year. They used a much more robust database and technological parameters that are closer to that of the predominant wind turbines being set up in onshore and offshore areas currently. Their estimate translates into 391 TW of wind farms operating at an average capacity utilisation factor (CUF) of 20 per cent. Current installations are a mere 0.05 per cent of this potential.

> **Immense technological transition has taken place in wind turbines and the engineering of wind turbines in the installations in India.**

In the context of India, an assessment of 48000 MW carried out in early nineties is widely circulated and referred to in industry and government circles. However, this assessment was made with limited data, and assumptions and technology parameters that are not relevant today. In the 2011 study *A GIS Based Assessment of Potential for Windfarms in India*, the potential for wind farms in the non-Himalayan regions of India has been assessed at 4.2 TW by Hossain et al. Wind is an opportunity created by the friction between the atmosphere and the surface of the earth. At a macro level, it can be assumed that on an average the wind potential is directly proportional to the land area. With this assumption, the independent studies cited above can be used to revalidate each other. The total surface area of India is 2.14 per cent of the land surface of the earth, therefore the assessed potential of 4.2 TW for India turns out to be 1.07 per cent of the global potential of 391 TW. In terms of order of magnitude, the results of the two independent studies are comparable and indicate that indeed worldwide potential for wind farms is of the order of 391 TW. We see that as far as wind resource is concerned, we are not at all constrained in meeting our energy needs.

Today worldwide, we have an ongoing debate on climate change, the need for bringing down CO_2 emissions and of ensuring energy security. These issues are of immense importance to India. Wind Energy presents a choice to the policy makers of the nation to plan generation capacity addition in an environmentally and economically sustainable manner.

> **Research and development (R&D) and engineering efforts are on to improve the efficiency of wind turbines, reduce weight and improve performance in operation.**

Wind Technology

Major Technological Trends

A major trend in wind turbine technologies, observed consistently since early eighties, is to build larger and larger wind turbines. The wind turbine ratings have changed from 25-40 kW to 7 MW and now 10 MW wind turbines are under development. Trends in ratings, hub height and rotor diameter are presented in Fig. 2, Fig. 3 and Fig. 4.

One can make out the immense technological transition that has taken place in wind turbines and the engineering of wind turbines in the installations in India. Trends in India mirror international trends except for the fact that there has been a lag of about 2 years. This is due to technology transfer issues often related to individual wind turbine suppliers. For example while Enercon Gmbh has installed 7 MW wind turbines in Germany, they have restricted themselves to 800 kW wind turbines in India. Offshore projects have not picked up in India, while in north European countries, the United States (US) and even China, offshore projects have been set up with wind turbines in the range of 3-5 MW. Vestas, a wind turbine supplier is to soon launch a 7 MW wind turbine, mainly for offshore projects.

A Norwegian Company Sway, a US company Clipper and the Chinese company Sinovel have independently announced their work on developing 10 MW wind turbines. A 10 MW wind turbine will have a hub height of 160 m and rotor diameter of 140 m. It will be meant for installations in deep offshore, perhaps as far as 80-100 km offshore. A better understanding of data, resources, engineering and economics pertaining to offshore projects can drive offshore markets in India and China also.

Other Technological Developments

With the main trend towards large wind turbines, the R&D and engineering efforts are on to improve the efficiency of wind turbines, reduce weight and improve performance in operation. Some of the thrust areas are:

Blade Design

Profiles of blades used in earlier turbines are based on National Advisory Committee for Aeronautics (NACA) profiles that result in maximum coefficient of performance of 0.3 to 0.4. Efforts are on to develop blade aerodynamic profiles that are better at harnessing wind energy. Enercon claims to have blades that can achieve up to 0.5 coefficient of performance. Blade profiles for different kinds of wind turbines have been designed by the US based National Renewable Energy Laboratory (NREL).

Blade Materials and Manufacturing

Lightness and strength of the materials is important for blades of large wind turbines with a rating of 5 MW, 7 MW or 10 MW. A blade is a composite material, therefore, the properties and interaction between materials during processing need to be well understood to produce high quality components. Materials used while manufacturing blades are birch plywood sticks, core material fibre rods, fibreglass and epoxy resin. In some designs, carbon epoxy is also used. Recently Alsthom has entered into agreements to develop ultra light but large blades (>60 m) (http://goliath.ecnext.com/coms2/gi_0199-14872002/Alstom-and-LM-to-create.html). R&D on blade materials can have an overall significant impact on wind turbine technology.

Mechanical Transmission

The mechanical transmission in a wind turbine generator (WTG) consists of all the components between the rotor and the generator. This includes, shaft, main bearings and

Fig 3. Trends in rotor diameter of WTG installations in India (m)

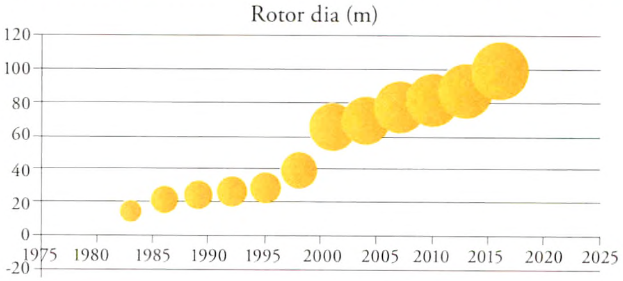
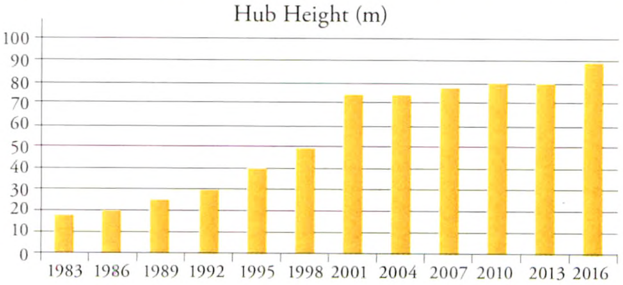


Fig 4. Trends in hub height (tower) of WTG installations in India (m)



gearbox. There are also gearless wind turbines in which intermediate transmission components including gearbox are done away with and instead we have a large ring generator connected to the rotor blades or rotor hub. Both kinds of systems are being used in the industry but increasingly, the trend is towards gearless wind turbines. This kind of system is considered more suitable for large wind turbines in the range of 5-10 MW because gearboxes for such large wind turbines are not being manufactured.

Variable Speed Vs Fixed Speed WTGs

Traditionally, the wind turbines used to be fixed speed, running at fixed revolutions per minute (RPM). However, a variable speed concept is considered more suitable because of the flexibility it offers in changing the rotor RPM. A variable speed wind turbine enables greater efficiency at wind speeds between cut-in and rated wind speeds of the wind turbine (3-12 m per sec). A variable speed turbine, due to the power electronics involved can also be grid friendly and minimise the reactive power requirements. Within the variable speed wind turbine category also we have geared and non-geared wind turbines and within the gearless category we can have wind turbines with permanent magnets and electromagnets. Each type has advantages and disadvantages associated with it. The tradeoffs need to be assessed by the investor. Wind turbines with doubly fed induction generators (DFIG) enable operation of wind turbine in a quasi variable state. It allows variation in RPM in the crucial range of wind speeds between cut-in and rated wind speeds.

Challenges

In about 10 years of implementation experience, wind turbines or wind power generation in grid connected mode as well as off grid mode has been firmly established as a resource and technology option. According to WWEA, given the fact that we have only harnessed 0.3 per cent of the total potential and perhaps 2-3 per cent of the electricity demand, we can conclude that what we see is just the beginning of the dissemination and proliferation of wind technology.

From a power system (grid) operation and system stability point of view, there are many challenges associated with wind power that need to be addressed. The main issues are:

- Wind is a fluctuating source and these fluctuations happen over timescales varying from a few second to the entire season.
- As a result the power output is also not firm.
- Wind farms are geographically dispersed and are generally set up in areas where the grid infrastructure is non-existent or limited.

On account of the above, many people and decision makers in the power sector, particularly those entrenched in the conventional power sector, look at wind energy with some level of scepticism. However, the challenges associated with integration of wind in the grid system can be addressed through technological innovation.

In future, it may be possible to manage wind farm fluctuation with different kinds of storage systems. The simplest is the hydro reservoir embedded in the power system, which can absorb these fluctuations. There are many kinds of storage systems that are being explored for wind turbines including chemical storage (battery), compressed air and pumped hydro. Wind turbine suppliers can also incorporate some storage with each wind turbine or it may be possible to have a storage system for the wind farm as a whole. Electric mobility that is being talked about in Europe would involve electric vehicles getting charged by the grid. These vehicles would offer inherent storage to the system that can be leveraged for higher levels of integration of wind with the grid. ✪

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Centre for Wind Energy Technology

Centre for Wind Energy Technology (C-WET) was established as an autonomous research and development institution by the MNRE to meet its broad goals and to tackle the challenges in sustaining the development and accelerating the pace of utilisation of wind energy in the country.

The Ministry of New and Renewable Energy (MNRE) established the Centre for Wind Energy Technology (C-WET) at Chennai in 1998–99 to cater to the emerging wind industry. Prior to that, the MNRE was providing policy-level initiatives to a field that was almost entirely dependent upon imported technologies and services. With an estimated 45000 MW of installed power, it was evident that necessary technical infrastructure has to be built up within the country. This was to neatly dovetail with an industry for which the investments for all aspects starting from manufacture to deployment came almost entirely from the private sector.

Wind turbine, being a complex, multi-disciplinary engineering product, requires in-depth knowledge of a variety of high-end technologies. With emphasis on manufacture and not on design, there is a risk of having technologies not entirely suitable to the Indian environment finding their way to India. C-WET's broad aim is to address this issue of making the Indian wind turbine designers and manufacturers take informed decisions on designs that are suitable for the Indian market.

C-WET offers prompt, credible, and innovative solutions at affordable costs to meet the requirements and expectations of clients. C-WET is committed to be a self-supporting focal point of excellence for the development of the wind energy sector.

> **C-WET is committed to be a self-supporting focal point of excellence for the development of the wind energy sector.**

Organisation

C-WET comprises five units, which are functionally organised.

- Research and Development
- Wind Resource Assessment
- Wind Turbine Testing
- Standards and Certification
- Information, Training and Commercial Services

Objectives

The objectives have been defined in keeping with the needs of the field:

- Serve as the technical focal point for wind power development in India, for promoting and accelerating the pace of utilisation of wind energy and support the growing wind power sector in the country.
- Develop and strengthen the facilities and capabilities; evolve strategies; and promote, conduct, coordinate, and support research and development (R&D) programmes to achieve and maintain reliable and cost-effective technology in wind power systems.
- Analyse and assess wind resources based on the data available from various sources and prepare wind energy density maps, wind atlas, and reference wind data.
- Prepare and establish standards, including guidelines, procedures, protocols for design, testing and certification of wind power systems, sub-systems and components, taking into consideration the Indian conditions and in line with internationally recommended practices and standards, and update the same based on the feedback.
- Establish world-class facilities, conduct and coordinate testing of complete wind power systems, sub-systems, and components according to internationally accepted test procedures and criteria, whereby the total performance that includes power performance, power quality, noise level dynamics, operation and safety systems is tested according to agreed protocols.
- Accord type approval/type certification, which verifies conformity with safety-related requirements as per standards, guidelines, and other rules for design, operation, and maintenance, as well as adequate documentation of quality issues such as power performance, noise, life expectancy, and reliability.
- Monitor the field performance of wind power systems, sub-systems, and components; effectively use this feedback for fulfilment of the above objective and issue of certification; establish and update the data bank on a continuous basis; and serve as information centre for selective dissemination.
- Undertake human resource development programmes for the personnel working in the wind energy sector.
- Promote commercial exploitation of know-how, know-why and results, and offer various consultancy services to customers.
- Promote the development and commercialisation of any other wind energy systems, including stand-alone systems.

Services Offered

Research and Development unit

The unit undertakes both topical and long-term projects as per the needs of an emerging technology of the present and future. The short-term projects concentrate on providing well-researched results to topical problems with technology such as modelling of inner connection of wind turbine to grid. Long-term projects look at technology development for the next generation.

Wind Resource Assessment unit

The unit conducts wind resource surveys for effective harnessing of wind energy. It also analyses collected data to identify high wind areas at macro and micro levels to provide support in micro-siting, and to carry out countrywide wind resource assessment.

Wind Turbine Testing Unit

The unit conducts testing of complete wind power systems according to International Electrotechnical Commission (IEC) standards at the Wind Turbine Test Station (WTTS) Kayathar, Tamil Nadu as well as at the customers site. The WTTS is presently equipped to undertake provisional type testing (PTT). Tests normally carried out under this category include power performance

Research and Development at C-WET

The R&D activities of C-WET are classified into five generic areas:

- Improvement in performance of existing wind turbine installations
- Research support for wind resource assessment
- Manpower training and human resource development (HRD)
- Technology support to wind power industry
- Research and advanced technology development

Ongoing projects in the R&D unit

- Development and validation of design methodologies and design tools for low and moderate wind regimes
- Setting up of R&D/experimental wind farms
- Testing of small wind turbines
- Modelling of interconnection of wind turbines with the grid
- Parameterisation of flow distortion around the wind turbine nacelle
- Installation of renewable energy devices

Research facilities available at C-WET

- Data Acquisition system
- Integrated sound level meter
- MATLAB software with toolboxes
- Power Analyser
- Digital Storage Oscilloscope
- AutoCad
- Bladed software for Windows
- A nacelle is installed in C-WET premises for demonstration.
- Pyranometer
- Mini Telemetry system.

test, safety and function tests, yaw efficiency test and load measurements.

Standards and Certification Unit

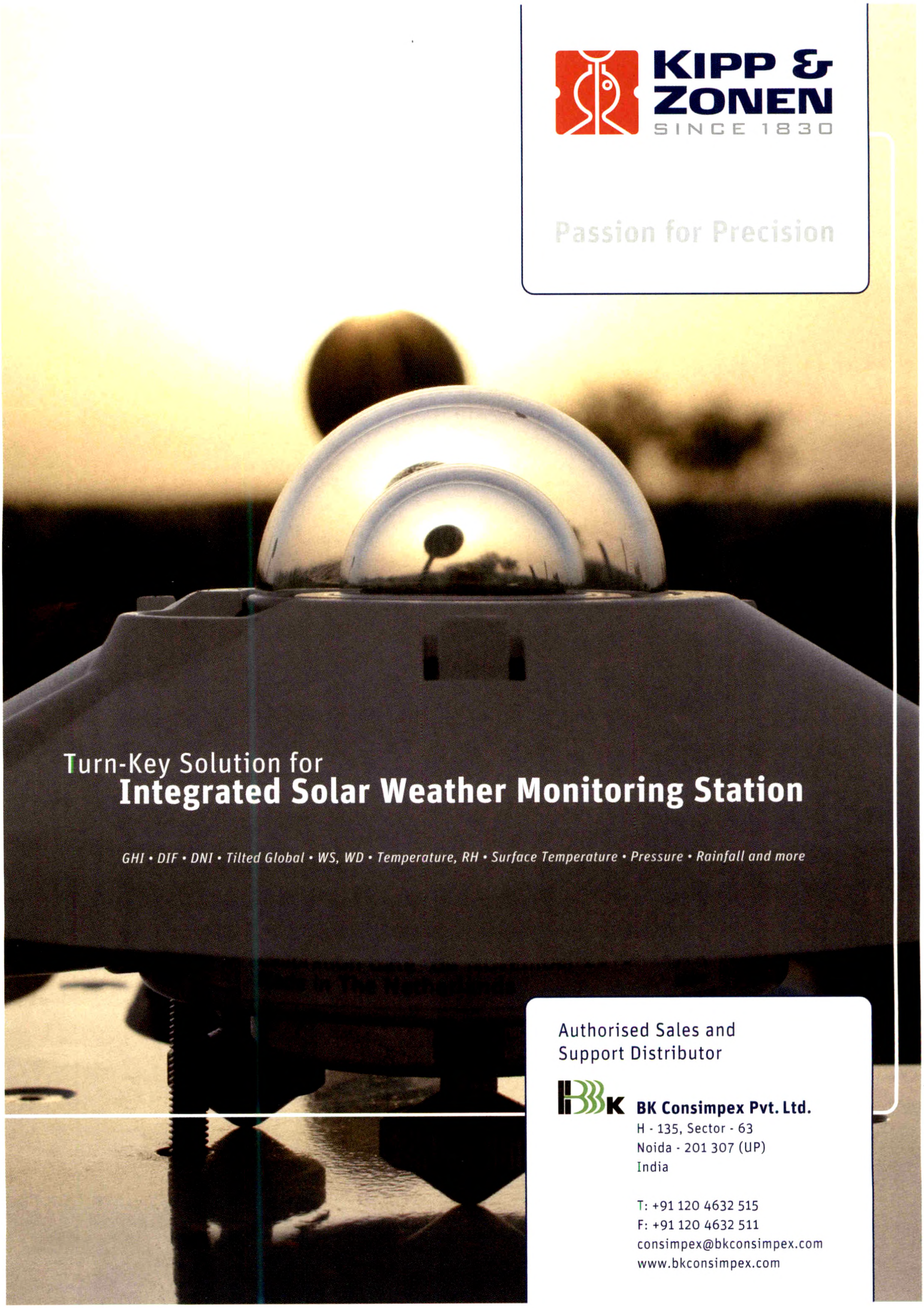
The unit accords type approval/type certification to wind turbines upon design verification in accordance with IEC standards and has developed additional requirements to be considered, which are exclusive to Indian operating conditions. The Unit prepared type approval provisional scheme - TAPS 2000 (amended), the Indian Certificate Scheme for wind turbine in line with international standard while taking into account Indian conditions.

Information, Training, and Commercial Services Unit

The Unit is engaged in dissemination of wind power related information to all stakeholders. It is the focal point for organising national and international training workshops for the benefit of stakeholders.

New Thrust Areas

- Facilitate the raising of capacity utilisation factor of the wind energy sector to 25 per cent by 2012.
- Facilitate lowering the costs of wind turbine systems to be at par or even below international prices.
- Facilitate lowering the cost of grid-interactive wind electricity to be at par with conventional electricity without factoring in externalities.
- Facilitate the achievement of the national goal of making the new and renewable energy sector a net foreign exchange earner; and in pursuance of this goal, to make the wind sector a net foreign exchange earner in the shortest possible time. ✪



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Wind Energy in India

Potential and Challenges

The development of wind power in India began in the 1990s, and has progressed steadily in the last few years. However, much remains to be done for wind to be able to make a meaningful contribution to the country's electricity requirement.

Narasimhan Santhanam

Wind energy has been the flag bearer for the Indian renewable energy (RE) industry for quite some time now. Investments in RE in India have increased from a meagre USD 94.58 million in 2001 to USD 3.7 billion in 2008 and about USD 5 billion by 2010 - at a phenomenal compound annual growth rate (CAGR) of 56 per cent. A significant part of these investments (USD 3.2 billion) were in wind energy. The increase in investment was driven largely by a sharp rise in asset finance, and this in turn was mainly due to the continuing spectacular growth of Indian wind capacity. Wind asset finance has been contributing an average 60 per cent of total RE investment in India in the past 3 years.

Indian Wind Power: a Success Story

The development of wind power in India began in the 1990s, and has progressed steadily in the last few years. The short gestation periods for installing wind turbines, and the increasing reliability and performance of wind energy machines have made wind power a favoured choice for capacity addition in India. Currently, India has the fifth largest installed wind power capacity in the world with a cumulative installed capacity of 14158 MW till the end of March 2011. Starting from about 1350 MW in 2001, this figure has been achieved at a CAGR of 26 per cent for the period 2001-11.

In addition to the progress made in wind turbine installed capacities, the progress of the overall wind energy ecosystem in India has been encouraging as well. A pointer to this is the increasing number of global wind turbine manufacturers setting up base in India. Indian policies have encouraged local wind turbine manufacturing by tuning the customs and excise duties such that they favour importing components over importing complete machines. India also has a national certification programme for testing and certifying wind turbines, under Ministry of New and Renewable Energy (MNRE), again intended to boost local manufacturing.

While the growth of wind power in India was largely driven by tax incentives until recently (through the accelerated depreciation scheme), it is expected that more independent power producers (IPPs) will be interested in investing in this segment with the announcement of generation based incentives (GBIs) in 2009. In fact, since 2010, and especially in 2011, there has been a flurry of announcements from the Indian corporate sector on their mega plans for large capacity wind farms.

The total potential for wind power in India was first estimated by the Centre for Wind Energy Technology (C-WET) at 45 GW, and was recently increased to 48.5 GW. This figure was also adopted by the government as the official estimate. At heights of 55-65 m, the Indian Wind Turbine Manufacturers Association (IWTMA) estimated that the potential for wind development in India is around 65-70 GW. The World Institute for Sustainable Energy (WISE) estimates that with larger turbines, greater land availability and expanded resource exploration, the potential could be as high as 100 GW. Energy Alternatives India (EAI) has done an independent research regarding the potential for wind energy in India through discussions with industry experts and researchers, and we estimate that the total onshore potential for wind energy could be as high as 120 GW.

Table 1. Summary of wind energy outlook scenario for 2020 - India

Growth Scenario	Cumulative Wind Power Capacity (MW)	Electricity Output (GWh)	Share of electricity demand (per cent)	Output (GWh)
Reference	20332	40665	2.6-2.8	610
Moderate	63230	126459	8.1-8.7	8247
Advanced	134828	269656	17.3-18.6	9438

Source: Indian Wind energy Outlook 2009 (Report by Global Wind Energy Council (GWEC)

> **Currently, India has the fifth largest installed wind power capacity in the world with a cumulative installed capacity of 14158 MW till the end of March 2011.**

A 100-120 GW potential for wind energy significantly widens the attractiveness of the Indian wind energy segment, given that the total installed capacity for electricity is India is about 177 GW (June 2011). An added bonus in the context of wind energy is offshore wind. India has a long coastline (about 7500 Km) and this augurs well for offshore wind. For instance, China's offshore wind potential is estimated to be about 250 GW, and USA's about 1000 GW. It is thus possible that India might have significant offshore wind potential too.

Thus, it appears that all is well with the wind industry. So, why should someone be concerned about a sector that is doing so well? As the Americans would say, why try to fix something that isn't broke? There are reasons, and a different reading of the data will show us why.

Wind's Real Contribution to India's Electricity Demand

Currently, wind power accounts for about 8 per cent of India's total installed power capacity, but it generates only about 2 per cent of the country's power. This gap exists because wind turbines have much lower capacity utilisation factors (CUFs) than do fossil fuel power plants, and also because of other infrastructural reasons such as sub-optimal evacuation of power etc. That is, for all the laurels that have been sung about wind, its contribution to India's electricity demand is currently negligible. If one now factors in the dramatic increase in electricity demand that India will face over the next decade, it is apparent that wind power's contribution will remain negligible if it grows at the current rates. Table 1 provides insights on possible contributions by wind energy to the total electricity produced in India by 2020.

The table provides predictions on three scenarios: reference (growth at current levels), moderate (annual installed capacity over 10 times the current level) and advanced (annual installed capacity over 15 times the current level). An analysis of the data shows that with a very ambitious realization in 2020, GWEC is projecting an 18 per cent share of electricity for wind energy in India, requiring 134 GW of wind power capacity. Under the reference scenario (with current growth rate), wind power will contribute less than 3 per cent of the total electricity demand even by 2020. These data show that India's wind energy penetration needs to grow by leaps and bounds in order to make a real difference by 2020. It is also important to note that India, while being a pioneer in wind energy in this part of the world, has lately started slipping when compared to relatively new entrants, especially China. A comparison between India's growth to that of China's will be instructive.

India's Wind Power Growth Vs That of Leaders

Until 2005, India was the clear wind energy leader in the developing world. But since then, it has been a poor second to China. Table 2 illustrates how India had been way ahead of China in terms of cumulative installed capacity until 2005, but how, by 2010, China's tally was more than triple that of India's! It should be noted that the US had also grown significantly during the 2005-10 period (about 38 per cent CAGR) compared to India (about 24 per cent CAGR).

For the 2002-2010 period, China had been growing at a phenomenal 75 per cent CAGR, and from 2005 onwards, its CAGR had been over 100 per cent - that is, the country's cumulative wind power installed capacity had been doubling EVERY YEAR, on average. While India's wind capacity growth had been better that of China's during the 2002-05 period, its growth had been dwarfed by the explosive growth of China during the 2005-10 period.

Thus, while India's growth in wind power looks impressive it needs to contribute more to the country's electricity requirements. The subsequent sections identify the key challenges that the Indian wind power industry faces and provides a roadmap that can help overcome these challenges.

Table 2. Cumulative wind power installed capacity (GW)

Country	2002	2005	2010
China	0.5	1.3	44.3
USA	4.7	8.1	40.2
Germany	12	18.4	27.2
Spain	4.8	10	20.7
India	**1.7**	**4.4**	**13.1**
Denmark	2.9	3.1	3.7

Compiled form various sources

Key Challenges

Global Positioning

India has been struggling to retain its global positioning mainly due to its conservative approach with wind energy density estimations. Further, India has shown relatively little dominance in the wind power manufacturing sector due to lack of promotions for local manufacturing. MNRE is addressing these issues in the upcoming 12th five year plan by revaluating wind energy potential at higher hub heights and by proposing local content requirements.

However, the proposed local content requirements are still not aggressive enough since most of the manufacturing bases in India are mere assembly units which import most of the components/subcomponents. India could follow along the lines of the Chinese policy which calls for 70 per cent local content for all components and sub components. This would promote wind ecosystem in India and eventually drive down the prices.

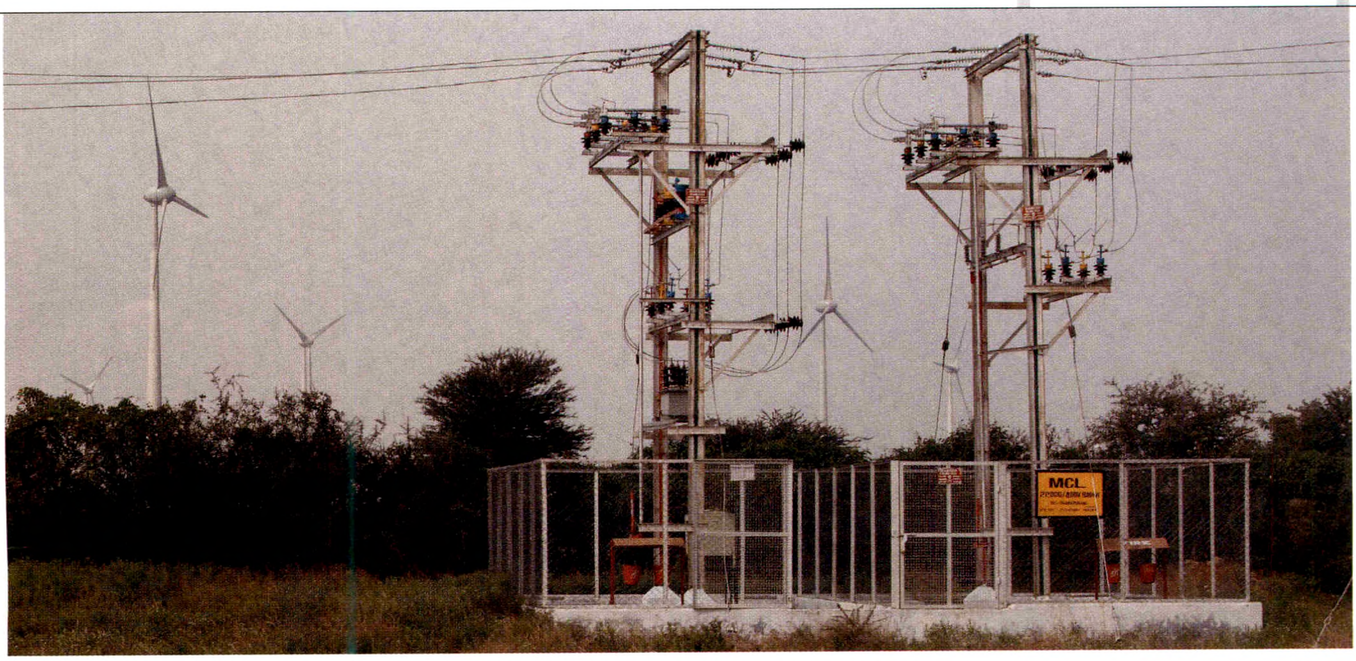
Transmission

Transmission infrastructure that is required to effectively absorb RE with its intermittency needs to be upgraded in most parts of the country. This is especially true of Tamil Nadu where most of the wind farms are idling because of grid instability and a shortage of evacuation facilities. Transmission infrastructure is the responsibility of state transmission utilities (STU). But many STUs are not financially healthy enough to invest in required transmission upgrades. Payment for transmission augmentation upstream of an interconnection point is a contentious issue. It is an onerous task to resolve the problem of poor grid infrastructure since there is lack of cooperation from state and central government entities, STUs, power plant developers and power purchasers.

Grid codes that include standards for wind integration are absent in the country and so the variable electricity production from wind farms has an adverse effect on the power system operation. It is imperative that the existing grid codes are modified to provide standards for system stability and reliability, not only in wind but in all renewable power.

Regulatory Challenges

Accelerated depreciation benefit has not been conducive for long term growth of this sector. Regulations across State Electricity Regulatory Commissions (SERCs) regarding renewable generation grid connections and transmission charges are vague and not uniform. Lowering and



standardisation needs to be achieved, to realise the potential of wind energy in the country. Given the fact that the task of promoting RE is a state subject, less than 10 states have implemented quotas for a RE share of up to 10 per cent. A national policy for wind energy which includes interstate grid availability needs to be brought in place. Though the lack of grid codes for wind is perceived as an infrastructural challenge, it is a regulatory challenge too and needs guidance from competent authorities in the government. The government should also call for proactive cooperation between STUs, developers and purchasers.

Technological Challenges

Estimation of effective turbine capacity is a serious technological challenge. Most of the turbine manufacturers are not willing to give a guarantee on performance.

The power performance of wind turbines connected to grids in India is adversely affected by grid parameters such as power outages, frequency fluctuations, voltage imbalances etc. Wind farm developers are not ready to invest on latest technologies that provide voltage, reactive and frequency control in order to maintain the electric system stability. The lack of willingness to invest in better technologies could be attributed to the fact that wind has been seen as a financial instrument. Also, there have been virtually zero efforts to exploit regions with low wind speeds. Adoption of low wind speed turbines, those that are class 3 or lower, remains a rarity in India.

Summary

At first sight, India appears to have made rapid strides in wind power. However, a more detailed analysis shows that in order for wind power to make a significant difference to the Indian electricity demand, today and in future, the sector needs to grow at a significantly higher pace.

The important challenges that the wind power industry faces in its efforts to achieve acceleration, call for a much needed transformation in the following aspects:

- The government must re-evaluate the wind energy policies adopted so as to make wind an attractive segment for investment post the anticipated removal of accelerated depreciation.
- The national grid needs restructuring - at the infrastructure level from the ground up, using lessons learnt from countries such as Germany to better accommodate wind energy farms as well as other RE systems. In addition to this, a robust regulatory framework in the form of grid codes would have to be developed and adopted. The onus for this falls primarily on the central transmission utilities (CTUs)/STUs with private investors playing a supporting role.
- Emphasis must be laid for better research and developmet (R&D) being done to promote domestic manufacturing of wind turbines that are more efficient, operate at low wind speeds and higher mast heights.
- A significant push must be made to provide updated estimates for the wind energy potential in India with efforts being made to evaluate the potential for offshore wind energy development.
- Active RePowering of old wind farms while accommodating technological improvements will ensure a better realisation of wind energy potential across the nation. ✪

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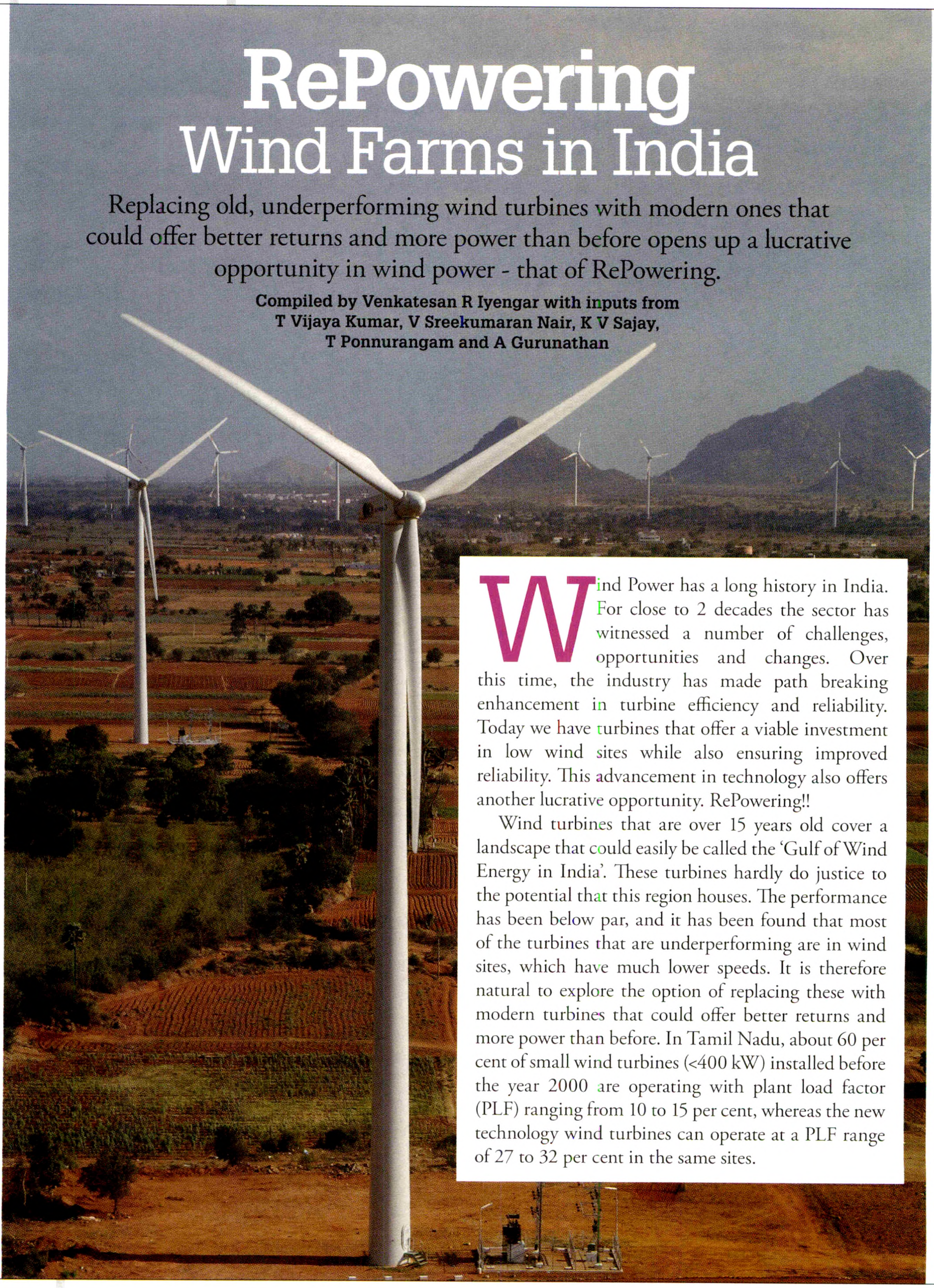
RePowering Wind Farms in India

Replacing old, underperforming wind turbines with modern ones that could offer better returns and more power than before opens up a lucrative opportunity in wind power - that of RePowering.

Compiled by Venkatesan R Iyengar with inputs from T Vijaya Kumar, V Sreekumaran Nair, K V Sajay, T Ponnurangam and A Gurunathan



Wind Power has a long history in India. For close to 2 decades the sector has witnessed a number of challenges, opportunities and changes. Over this time, the industry has made path breaking enhancement in turbine efficiency and reliability. Today we have turbines that offer a viable investment in low wind sites while also ensuring improved reliability. This advancement in technology also offers another lucrative opportunity. RePowering!!

Wind turbines that are over 15 years old cover a landscape that could easily be called the 'Gulf of Wind Energy in India'. These turbines hardly do justice to the potential that this region houses. The performance has been below par, and it has been found that most of the turbines that are underperforming are in wind sites, which have much lower speeds. It is therefore natural to explore the option of replacing these with modern turbines that could offer better returns and more power than before. In Tamil Nadu, about 60 per cent of small wind turbines (<400 kW) installed before the year 2000 are operating with plant load factor (PLF) ranging from 10 to 15 per cent, whereas the new technology wind turbines can operate at a PLF range of 27 to 32 per cent in the same sites.

The RePowering Potential

The total installed capacity before 2002 was 1380 MW (Table 1). Most of these turbines were installed in Class I and II locations with smaller capacity turbines paving way for potential RePowering and thus better resource utilisation.

Key Factors

Wind Study and Micro-siting

Micro-siting is necessary for the optimisation of wind farm layout and locating new turbines as per the norms specified by respective state regulatory authorities. Since there would already be an existing wind farm, site prospecting is not an issue and it only needs to be validated with current wind/meteorological data to finalise the capacity and number of new wind turbine generators (WTG) that need to be replaced.

Micro-siting for a RePowering site would be a real challenge for the site personnel due to the presence of existing wind turbines in and around the site. Apart from maintaining the correct distance between the machines being proposed, it should be ensured that none of these machines violates the norms regarding inter-machine distance prevalent in the corresponding state. Any discrepancy in the micro-siting of the existing machines would adversely affect the micro-siting of the new wind turbines.

Removal of Existing Turbines

It is important to decide on the number and capacity of older machines to be removed as per the micro-siting details. Economic feasibility/viability is an important factor influencing the capacity and quantity of older machines to be removed based on the RePowering factor. The removal of older running machines should be timed and planned properly to avoid any generation losses and at the same time, to not create any hindrance to the installation of new WTG.

Table 1. The RePowering potential - state wise wind turbine installations before 2002

State	Total capacity (MW) installed before 2002
Tamil Nadu	809.8
Maharashtra	247.8
Gujarat	175.1
Andhra Pradesh	86.7
Karnataka	28.9
Madhya Pradesh	22.6
Rajasthan	4.1
Others	5.1
Total	**1380**

Source: Consolidated Energy Consultants Ltd. (CECL)/Ministry of New and Renewable Energy (MNRE)

> **Micro-siting for a RePowering site would be a real challenge for the site personnel due to the presence of existing wind turbines in and around the site.**

Installation of New Turbines

It is essential to ensure that the installation of new wind turbines in the existing wind farms does not affect the operation of existing wind turbines and vice versa. It is also important to plan the project well in advance to ensure that access roads, platforms, storage area and removal/rerouting of the existing lines for moving new WTG components inside the wind farms is smooth and does not affect any wind turbines in the vicinity.

Challenges

The challenges include securing necessary approvals and licenses from authorities as well as ensuring a favourable policy and maintaining regulatory transparency and support. It would benefit the industry to replace the inflexible, arbitrary and bureaucratic spacing requirements with a more flexible, fact based regulations. The Government should also encourage RePowering through various forms of incentives for capacity addition, increase in tariff, etc.

Gamesa's RePowering Initiative Project Avatar

Super Sales India, a part of the Lakshmi Machine Works (LMW) Group joined hands with Gamesa in implementing the first RePowering project in India named 'Project Avatar'. At the selected site, the existing

In general, information/details required to complete micro-siting are: ■ The boundary details of the site proposed for RePowering ■ Coordinates of the existing wind turbines at the site and the details of the wind turbines (such as make, capacity, rotor dia, hub height, power curve etc.) ■ Coordinates of all the nearby wind turbines of other customers and the details of the wind turbines (such as make, capacity, rotor dia, hub height, power curve etc.) ■ Wind data based on which earlier micro-siting was done. If wind data is not available, atleast predominant wind direction should be available ■ Wind data for any later period from the same mast or from any new mast nearby if available ■ Applicable micro-siting guidelines of the corresponding State.

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Economic feasibility/viability is an important factor influencing the capacity and quantity of older machines to be removed based on the RePowering factor.

wind farm consisted of 29 units of 300 kW turbines and 2 units of 500 kW turbines at Kethanur village in Tirupur district, Tamil Nadu. Gamesa undertook a detailed study of the site and surrounding area and recommended that the 11x300 kW turbines could be replaced with 4 units of Gamesa G58-850 kW machines, which would improve the overall performance and output because of a higher efficiency factor. The 1st phase of this RePowering project was undertaken in March 2011. In July 2011, another repowering project in Aralvoimozhi was commissioned, where 3 units of the Gamesa G52-850 kW replaced 11 turbines - 10 units of 250 kW and 1 of 225 kW.

Project Avatar conceptualised and implemented by Gamesa has resulted in significant benefits to the customer:

- Installation of suitable turbines for a specific site i.e. a class III turbine for a class III project site as per International Electrotechnical Commission (IEC) classification.
- Replacing obsolete technology with technologically advanced variable drive, grid friendly Gamesa G58 – 850 kW turbines that have a 58 m rotor dia and 65 m hub height, thereby increasing the average PLF to 27 per cent.
- Improved overall performance and hence increased power generation from 12.5 million units to 30.0 million units, for the same capacity and with existing evacuation infrastructure.

Gamesa is working with a more investors to adopt a similar concept by offering customised site wind power solutions based on a detailed project evaluation.

Benefits

More wind power from the same area of land: Wind power generation is multiplied without the need for additional land, efficient use of potential land and more capacity addition per unit of land area. A typical example comparing existing scenario and RePowering proposal for a wind farm in Coimbatore is given in Table 2.

Table 2. Comparison of existing scenario and RePowering proposal

Parameter	Wind farm	
	Existing	Gamesa
Capacity	8.1 MW	8.5 MW
Annual estimated generation	104 lakh kWh	220 lakh kWh
PLF	14.70 per cent	29.50 per cent

From the table it is evident that for a similar capacity wind farm, the increase in annual electricity generation using Gamesa model WTG of rated capacity 850 kW is 116 lakh units. By opting for RePowering, one can expect an increase in generation of more than 100 per cent than the existing capacity.

Fewer wind turbines: The number of turbines is greatly reduced while the natural landscape is maintained.

Higher efficiency, lower costs: Modern turbines make better use of available wind energy, thus improving efficiency of the wind farm and lowering the operation cost.

Better performance: Modern turbines rotate at much lower speeds and thus reduce the noise level.

Better power grid integration: Modern turbines offer much better grid integration since they use a connection method similar to conventional power plants and also achieve a higher utilisation degree.

Grid compliance: New machines would be able to fulfil the grid code requirements.

Reactive power: New Machines will consume less reactive power.

Endnote

The repowering potential and its benefits offer an attractive opportunity to improve the quality of power generation and efficiency of the wind sites. The right policy framework and incentives could significantly change the landscape of aging wind farms in India. ✪

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Did You Know

- There is evidence that wind energy was used to propel boats along the Nile as early as 5000 BC. *(www.uk-energy-saving.com)*

- Wind energy is a form of solar energy. Winds are caused by the uneven heating of the atmosphere by the sun, the irregularities of the earth's surface, and rotation of the earth. Wind flow patterns are modified by the earth's terrain, bodies of water, and vegetative cover. This wind flow, or motion energy, when 'harvested' by the wind turbines, or modern-day windmills, can be used to generate electricity. *(www.esru.strath.ac.uk).*

- Wind energy theory was discovered/formalised in 1919 by German physicist Albert Betz and published in his book Wind-Energie. *(http://interestingenergyfacts.blogspot.com)*

- The power from the wind is proportional to the cube of wind velocity, air density and the area swept out by the blades. Therefore the faster the air transfer and the large the blades the greater the amount of energy that can be converted. *(www.cyberphysics.pwp.blueyonder.co.uk)*

- Turbines are designed to last for 20 years and after being decommissioned (taken down) around 80 per cent of the turbine is recyclable. *(www.theclean.org)*

- The opposition usually met for a proposed wind farm development comes down to the 'NIMBY' factor (not in my backyard). *(www.energy-facts.com)*

From India

- Maximum installation in a State: 5904 MW, Tamil Nadu (as on 31 March 2011)

- Maximum estimated gross wind power potential in a State: 10609 MW, Gujarat

- Maximum number of Wind Monitoring Stations installed in a State: 112, Maharashtra

- Highest capacity addition in a financial year: 2349 MW during the year 2010-11

- Highest capacity addition in a financial year in a State: 997 MW during the year 2010-11, Tamil Nadu

- First Wind Monitoring Station in India: Sultanpet, Tamil Nadu, established on 28 July 1986 *www.windpowerindia.com*

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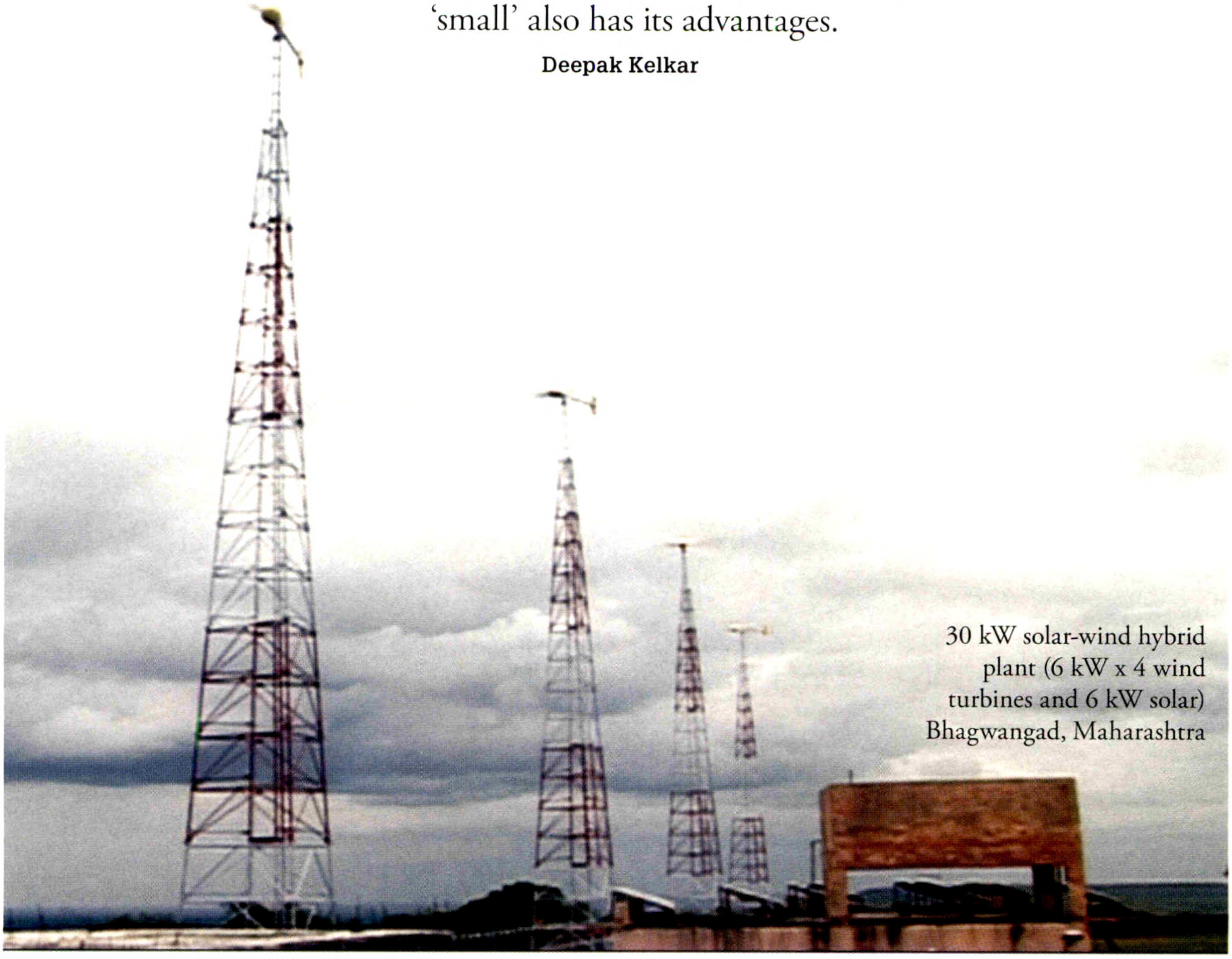
SMALL WIND TECHNOLOGY
AND APPLICATIONS

At a time when harnessing of wind power is gaining momentum, the size and the generation capacity of the wind turbines has become a crucial factor. 'Big' seems to be the buzzword, but 'small' also has its advantages.

Deepak Kelkar



30 kW solar-wind hybrid plant (6 kW x 4 wind turbines and 6 kW solar) Bhagwangad, Maharashtra

The ever increasing requirement of electrical power and defecit on the grid, led to the idea of harnessing wind power and utililising the same for various purposes. History shows that many wind turbines were built during the British era for pumping water from open wells. However today we have what is called big and small wind - the major difference actually is between big and very big. Also, the power generated has to be fed into the grid at relevant voltages and these turbines cannot be mounted on rooftops or in small farms. Meaning that power generated has to be injected in the grid and cannot be used at the point of generation. These turbines also require exitation voltage to start. This is where the small wind comes into the picture injecting power at the point of utilisation. However, without having micro siting done the performance in terms of plant load factor (PLF)/capacity utilisation factor (CUF) is comparatively lower than that of 'big brother' - the big turbines.

The technology used in 'small' wind is direct driven permanent magnet generators which start developing power at the lowest wind speed of 2.2 m per sec. That is the reason why small wind is normally coupled with a solar source to make it a wind-solar hybrid system. This is in tune with the natural phenomenon that when we have a blazing sun, forget wind and when the sun is down then we experience breeze/wind.

Typically since the power produced by small wind generators is stored in battery banks the performance of the wind turbine is indirectly controlled by the behaviour of the battery bank. Ideally every watt produced by small wind has to be counted for and used, but if the battery bank is full and load is not switched on then the power produced is wasted and not accounted for.

The cost factors of small wind turbines are today heading south, this is for the turbines. However the hardware cost like towers, self standing or guyed, electrical systems involved, or in a nut shell - balance of the system (BOS) - are detterent factors and these factors actually have more percentage expenditure than the cost of wind turbines. Ultimately for any end user the capital cost of a wind project including entire BOS has to the cheaper and here the Government of India through Ministry of New & Renewable Energy (MNRE) is supporting the technology by providing appropiate capital subsidy to small wind and small wind+solar hybrid systems, effectively.

Off Grid – Stand Alone Application

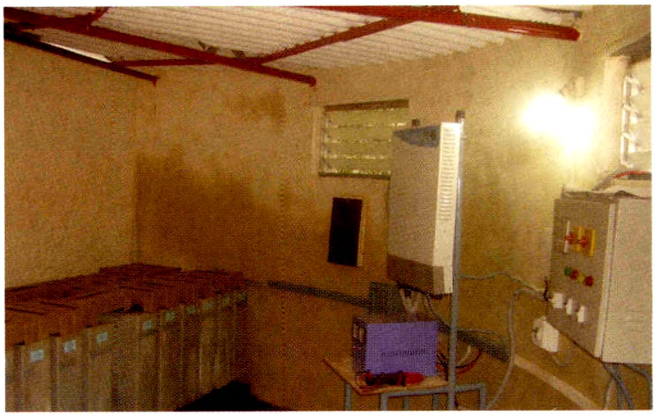
Almost all the systems installed in India today are off grid or stand alone. The power developed from the wind turbine which is 3 phase AC power varying in voltage, current, and frequency depending on the wind velocity is converted into the DC power which is used to charge the appropiate battery bank and then further used to power the utilisation points through inverters. Mostly these systems are installed in remote locations where grid power is not available.

The entire conversions from AC to DC and back to AC through battery bank takes a toll on the system performance. The battery bank plays a crucial role here, normally lead acid deep discharge batteries are used for their robust construction and deep discharge qualities and system integrators have to match typical Ah In = Ah Out equation. And to maintain the load at Ah Out side one has to design a sytem wherein Ah In should be atleast 30 per cent greater then the Ah Out. Experience of building these systems and monitoring these outputs is very critical as is also the ambient temperature for the batteries to perform to their mark.

> **The technology used in 'small' wind is direct driven permanent magnet generators which start developing power at the lowest wind speed of 2.2 m per sec.**

Looking back to 'big brother' (big wind) scenario it is important to understand that in India 70-80 per cent power output of big turbines is during the pre-monsoon and monsoon period. This fact is also true for the small turbines. More power from small wind is also available during this period. The annual average output term which is normally used in all renewable energy (RE) especially with regard to solar and wind is a bit deceptive because in case of small wind the entire design actually works on energy produced per day, it has to meet the daily needs of the energy at the point of utilisation. And in pre-monsoon and monsoon period when the turbine produces more power then the battery bank becomes a bottleneck for storing the power. Building huge battery banks is also not economically feasible.

Using a battery bank (typically lead acid flooded types) in renewable applications raises the argument whether this can then really be called 'green' energy when one is using lead-acid which is hazardous for the environment. However the



Control room of the 10 kW wind-solar hybrid System for Akshi Grampanchayat, near Alibag, Maharashtra.

> **Another application of small wind farms coupled with solar power is their installation at various remote locations along the transmission lines.**

bright side of the application is that if small wind and solar become partners in big way, they may be the only viable solution for the power needs of many remote locations. The percentage of partnership may vary depending upon the location and weather data. However, on a rational level we need to understand that RE cannot wholly replace conventional power, but that it can save conventional power to a great extent and maybe reduce the import in general of coal, oil etc.

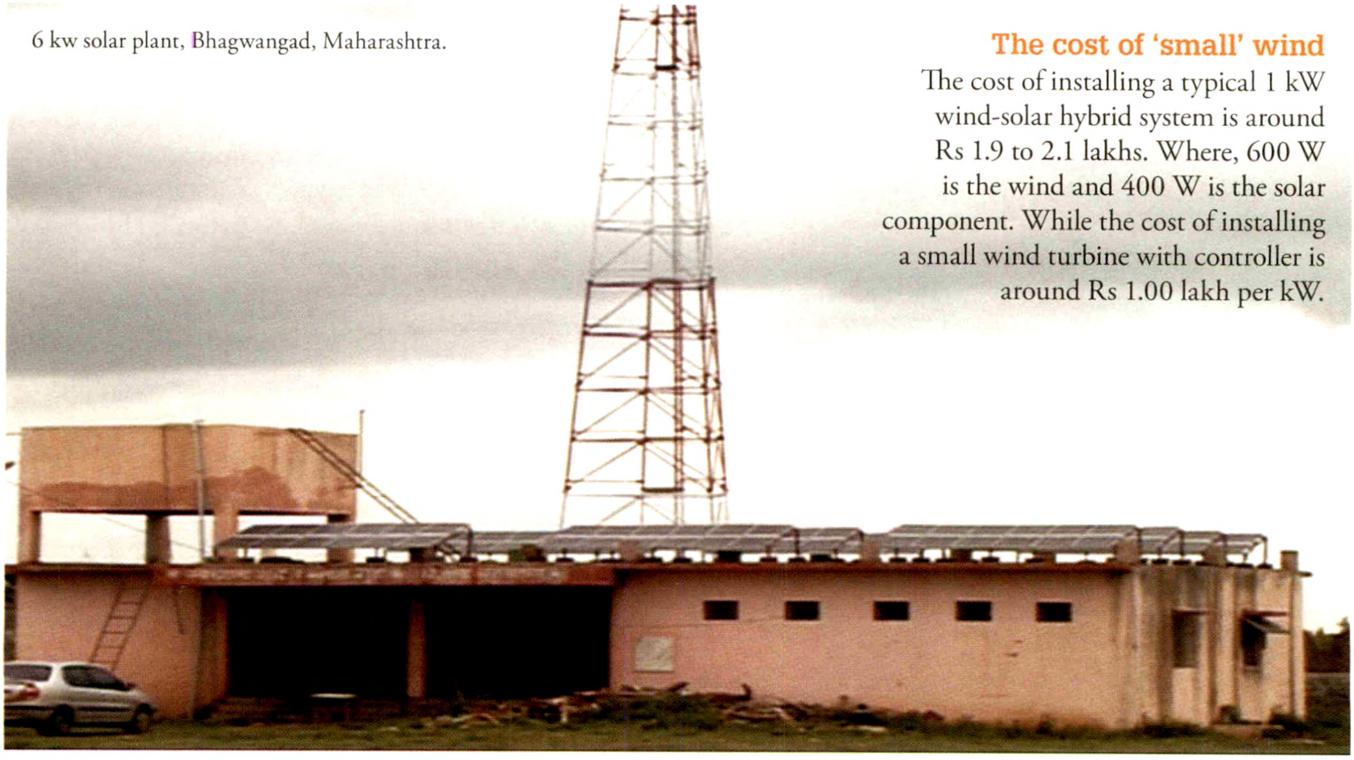
Another application of small wind farms coupled with solar power can be their installation at various remote locations along the transmission lines wherein power from these small installations can be pumped into the transmission lines to stabilise the: voltage thereby reducing the transmission losses. Reduction of transmission losses will immediately increase the power availability on the national/state grid.

On Grid - Application

A perfect solution for building small plants where grid is reliable is to increase the strength of the transmissions 'in grid'. Today one can synchronise wind power even from small wind with the grid. The grid has to be built to accept such power and a new era of net metering for small wind application can begin. Information Technology (IT) corporates can use such systems in their premises as most have built their internal grids backed with huge diesel generator (DG) sets. Critical loads can be met through such systems, so that power produced from small wind can be synchronised with internal grids built by backup DG power.

Small Wind Generators and Balance of System

Small wind generators used in India are normally horizontal axis upwind turbines and are tested for their performance by Centre for Wind Energy Technology (C-WET), Chennai. C-WET tested and certified turbines qualify for the subsidy programme of the MNRE. Generators of various capacities are available all across the globe, from 300 W to 30 kW turbines with various aspects like rotar diameters, furling mode/pitch control turbines etc. depending on the manufacturer.



6 kw solar plant, Bhagwangad, Maharashtra.

The cost of 'small' wind

The cost of installing a typical 1 kW wind-solar hybrid system is around Rs 1.9 to 2.1 lakhs. Where, 600 W is the wind and 400 W is the solar component. While the cost of installing a small wind turbine with controller is around Rs 1.00 lakh per kW.

Government Programme on 'Small Wind Energy and Hybrid Systems (SWES)' 2011-12

The programme supports deployment of water pumping windmills (wind pumps) and small aerogenerators/ wind-solar hybrid systems for water pumping applications and generation of electricity in off grid mode, respectively. Grid connected wind solar hybrid systems may also be taken up for demonstration purpose if state regulatory and other related issues are favourable. General packet radio service (GPRS)/ supervisory control and data acquisition (SCADA)/broadband/ other such technology based systems are to be used for remote monitoring of SWES systems on demonstration basis.

All categories of users including individuals, farmers, NGOs, Central/ State Government agencies, local bodies and Panchayats, autonomous institutions, research organisations, cooperative societies, corporate bodies, business establishments, banks, etc. are eligible for having the systems installed for their use.

Aerogenerators

The rated capacity of individual aerogenerators covered under the programme will be up to a maximum of 100 kW, however, Ministry of New and Renewable Energy (MNRE) support for installation of aerogenerators will be restricted to a maximum total capacity of 10 kW (project capacity). Both imported and indigenously manufactured/assembled aerogenerators are covered under the programme. However, only the MNRE empanelled models of the aerogenerators will be eligible for financial support under the scheme.

Hybrid Systems

Hybrid systems based on a combination of various renewable energy sources like wind and solar photovoltaic (PV) are covered under the scheme. The hybrid systems will be designed to meet the annual load requirement with optimum use of resources. The rated capacity of individual aerogenerator covered under the programme will be up to a maximum of 100 kW, however, MNRE support for installation of a wind-solar hybrid system will be restricted to a maximum capacity of 50 kW (system capacity). The wind component of the hybrid system has to be at least 60 per cent of the total capacity. ✪

Relevant standards as per International Electrotechnical Commission (IEC) are mentioned on the web site of MNRE and C-WET. For small wind turbines, tower becomes the most important factor for the performance, ofcourse we need to look into the cost implication as regards the hub height of turbine from ground level also. The safety factor will play a major role typically for towers built in vicinity of buildings and dwellings. A certfied generator will always have an upper hand in the market because the ratings and safety features as regards to blades etc. are third party tested and approved. Performance is also rated for the knowledge of end user.

Efficient electronic controllers and maximum power point tracers can actually squiz all the power available from the wind as usable power to charge batteries efficiently. A maximum power point tracking (MPPT) alogarithm has to be written for the particular turbine and incorporated to deliver the power. This alogarithm and charge controllers have to be selected or build up properly for each type of turbine depending upon its volt revolution per minute (vrpm) - and connect and disconnect the turbine from load as the case may be.

Though most of the time horizontal upwind turbines are used, verticle axis turbines also show a lot of potential and ease of operation of turbine. The major advantage in verticle axis being the natural dynamic balance it provides on the tower, thus lowering stress on the tower.

Ultimately, for anybody whether in a standalone or grid tied application what matters most is to have the lowest cost of generation i.e. Rs per kWh cost. While calculating these costs all the factors like capital expenditure (capex) and operational expenditure (opex) are considered. Hence today's requirement boils down to lowering this generation cost by reducing capex and opex costs while simultaneously increasing the generation from the system.

Small Wind Association is a platform for all the concerned people in the Industry including end users. The Association with help of the Ministry and C-WET looks to act as a facilitator in improving the quality and quantities of the systems. This would wire up the end users, manufacturers and system integrators and enable appropiate representation in policy formulation for the Ministry. ✪

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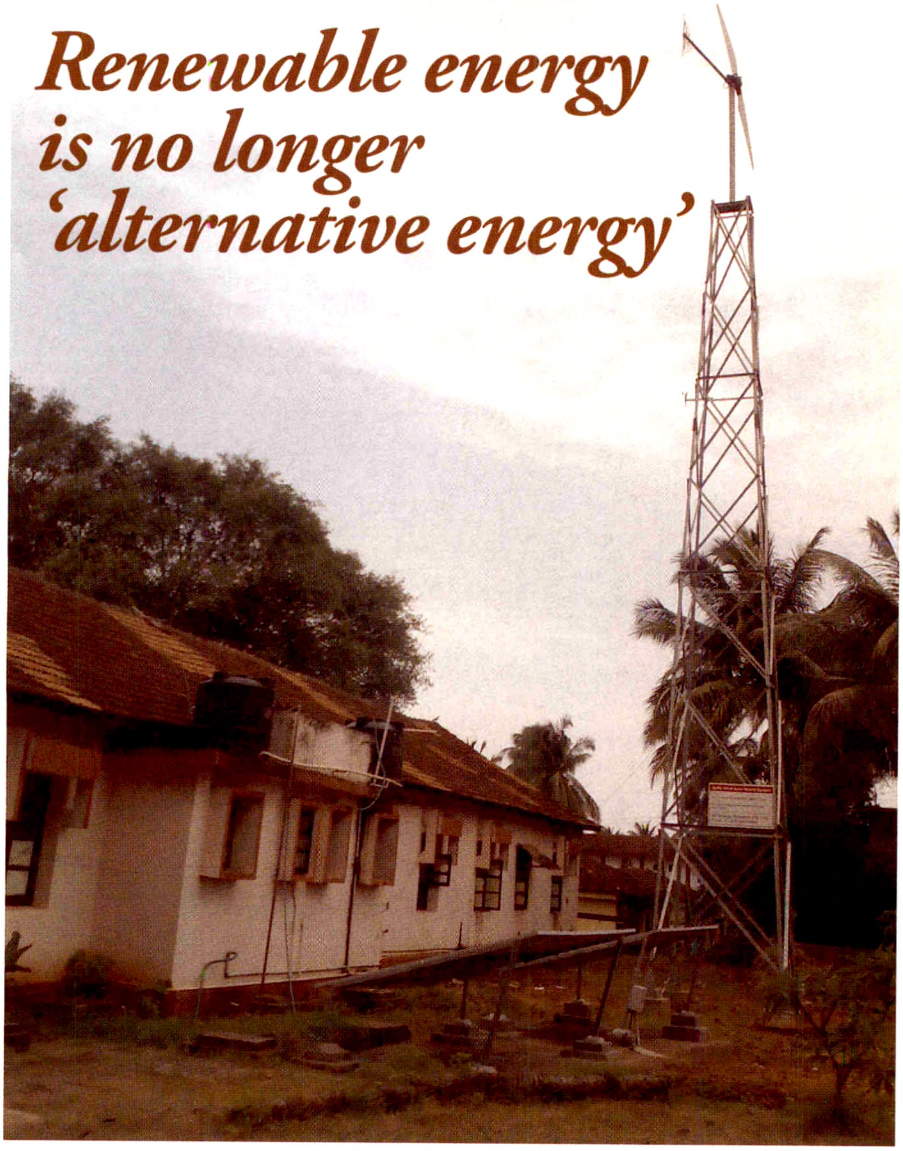
Renewable energy is no longer 'alternative energy'



The author opines that it is time to accept renewable energy as a 'mainstream' source since it is proving to be a viable 'replacement' for conventional sources of energy.

Anish De

As the country embarks on planning for the 12th Plan (2012-17) period, a key question mark that hangs over the process is on the energy requirements. Growth is energy hungry, and the aspirations of growing at 9-10 per cent will place huge demands on the energy resources of the country. In this energy jigsaw, renewable energy (RE) will feature like never before in the 12th Plan and after.

By the rule of the thumb, India will require about 100 GW - 100000 MW - of capacity addition in the next five years. Encouraging trends on energy efficiency and sustained efforts by some parts of the government - the Bureau of Energy Efficiency (BEE) in particular needs to be complimented for this - have led to substantially lesser energy intensity of economic growth. However, even the tempered demand numbers are unlikely to be below 80 GW. As against this need, the coal supply from domestic sources is unlikely to support more than 25 GW equivalent capacity. Imported coal can add some more, but at a much higher cost. Gas based electricity generation is unlikely to contribute anything substantial in view of the unprecedented gas supply challenges. Nuclear will be marginal in the foreseeable future. Between imported coal, gas, large hydro and nuclear, no more than 15–20 GW equivalent can be expected to be added in the five-year time block.

As against this, capacity addition in RE based power generation has touched about 3 GW a year. In the coming five years, the overall capacity addition in the electricity grid through RE is likely to range between 20 GW and 25 GW. Additionally, over and above the grid based capacity, off grid electricity applications are reaching remote places and touching lives where grid based electricity supply has miserably failed. Newer applications in lighting, heating and household applications are now reaching a point of 'unconditional competitiveness'. All of this is at a substantially lower carbon footprint. Renewable is thus no longer 'alternative energy', it is pretty much as mainstream as it gets.

The bottlenecks to RE

development are more practical. The nature of 'infirm' electricity from renewable sources is somewhat different from conventional coal, gas or nuclear power. Large scale ingress of such infirm electricity in the grid causes grid management problems. A utility control room becomes a much more complex and busier place as the proportion of renewable electricity increases. There is a natural reluctance on part of utilities to take in renewable electricity beyond a point.

Key to solving this conundrum is recognising that renewable power is indeed infirm, but is predictable. Predictions made with reasonable accuracy on how much electricity will be generated at any time will lead to solutions being developed by pressing in quick response complementary sources of electricity to complement RE generation. Thus, pairing solar with gas, and wind with storage hydro can address the key issue of variability. This is more a management issue, and with the right policies and regulations on these aspects renewable electricity generation can receive a huge fillip.

That would still leave the issue of local grid management where large scale variations in generation can cause huge disturbances and lead to grid outages. This will need to be addressed through network strengthening and introduction of newer technologies such as Flexible AC Transmission Systems (FACTS). Eventually, large scale renewable resources such as wind and solar would need to connect with the national grid and the power flows would become a part of the inter-state power flows.

Pairing solar with gas, and wind with storage hydro can address the key issue of variability. With the right policies and regulations, these aspects of renewable electricity generation can receive a huge fillip in India.

Fortunately, in the area of RE, India has been seeing quite a bit of progressive action led by the Central Electricity Regulatory Commission (CERC). The regulator has acted extremely proactively to ensure that a Renewable Purchase Obligation (RPO) is implemented at the state level. This has been backed by innovative commercial mechanisms such as tradable Renewable Energy Certificates (RECs) that help states, which are deficient in RE resources, fulfil their purchase obligations. CERC has also made it mandatory to bring about 'scheduling' of grid connected RE from January 2012. This will bring about the much desired predictability and reduce the impact of infirmity of the main RE resources - wind and solar.

On its part the government of India has been working on filling some of the loopholes in the policy framework and the implementation wherewithal. A credit enhancement mechanism for the solar projects under the first phase of the National Solar Mission (NSM) has been put in place. The government has also approved the use of the proceeds of the coal cess accruing to the National Clean Energy Fund (NCEF) for investments in the transmission grid and improving reliability. A number of market innovations are also being proposed by the government to promote competition and bring down cost of RE production and delivery.

All of these are positive pointers in the otherwise troubled energy scenario that the country is facing. However, it comes with an important caveat. RE resources are very local. For grid based electricity production the resources are concentrated in a few states. Development is mired in land related issues, availability of permits, consents and clearances - all the typical issues that bog down infrastructure project development in India.

If the promise of RE has to play out in practice, the government would need to demonstrate sustained leadership to overcome the issues, address state level parochial attitudes through the right mix of incentives, and remove bureaucratic sloth in the state machineries. Investor interest in RE is high at this time, but can be very fickle. One has always suspected that the National Action Plan for Climate Change (NAPCC) and its ambitious targets were born out of propaganda rather than belief. However, a combination of circumstances may just make achieving some of the important targets possible to a significant degree. It is crucial that the country and its leadership do not let the opportunity pass. ✪

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This opinion first appeared in
www.livemint.com

Sardar Swaran Singh National Institute of Renewable Energy

SSS-NIRE is an autonomous institute of the Ministry of New and Renewable Energy and it is fast developing into a centre of excellence for biomasss energy.

Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE) Campus, Wadala Kalan, Kapurthala District, Punjab

Sardar Swaran Singh National Institute of Renewable Energy (SSS-NIRE), at Wadala Kalan, Kapurthala district, Punjab is an autonomous institution of the Ministry of New and Renewable Energy (MNRE), Government of India. Spread over a sprawling campus of about 75 acres, the institute is fast developing into a centre of excellence for biomass energy. The Governing Council under the Chairmanship of Secretary, MNRE has been directing and monitoring the progress of the Institute.

Objectives of SSS-NIRE are to carry out and facilitate research, design, development, testing, standardisation and technology demonstration eventually leading to commercialisation of research, development and demonstration (RD&D) output with a focus on

- bioenergy, biofuels and synthetic fuels in solid, liquid and gaseous forms for transportation, portable and stationary applications; and
- development of hybrid/integrated energy systems. And also to undertake and facilitate human resource development and training including post-doctoral research in the area of bioenergy.

Functions

The Institute proposes to work in the area of: solid fuel laboratory on biomass characterisation, combustion, pyrolysis and testing of chulha, liquid fuel laboratory on biodiesel, bio ethanol and hydro cracking of vegetable oil, and gaseous fuel laboratory on producer gas, biogas and bio hydrogen.

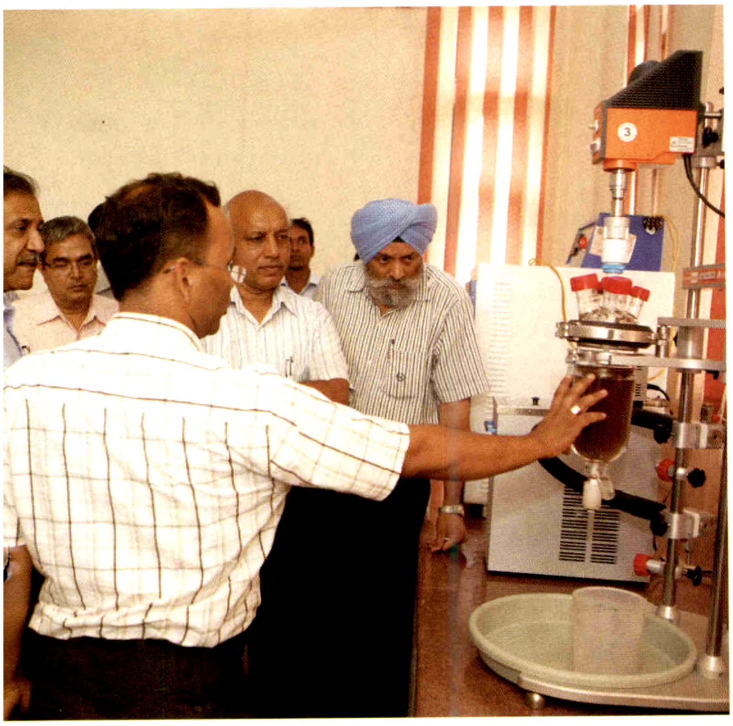
Objectives of SSS-NIRE are to carry out and facilitate research, design, development, testing, standardisation and technology demonstration.

Major Research Goals

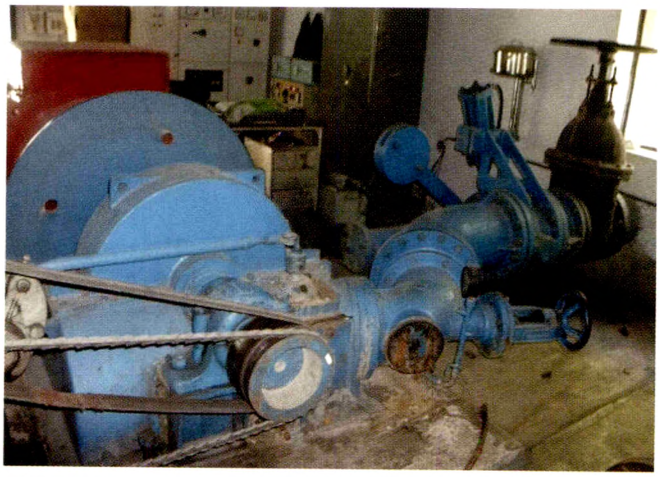
- A data base generation on fuel related characteristics of biomass and other fuels and application of biomass for specific technologies.
- Biomass management i.e. harvesting, collecting, transportation, storage and pre-conditioning studies.
- Technology development for the production of bio ethanol using lingo-cellulosic materials, especially the agricultural crop residues and its application.
- Technology development relating to thermal conversion of biomass such as gasifier designing/fabrication, combustion of biomass and power generation, biomass pyrolysis and the performance evaluation of the systems and economic appraisal.
- Technology development for production of biooil/ lignoil, bio crude production and integrated bio refinery development.
- Establishment of testing centre for chullas for domestic applications, biomass thermal gassifiers and other renewable energy (RE) devices.
- Generation of biogas from animal excreta and agricultural wastes, purification of the biogas, its bottling and commercial application of both carbon dioxide and methane.
- Hydrogen generation from biomass resources (using producer gas and biogas both generated from biomass).
- Study on the growth characteristics of different varieties of oil bearing plants such as Jatropha Curcus and others.
- Development of biodiesel production parameters using non-edible and waste oils, different types of catalyst, feed stocks and the use of biodiesel as fuel in diesel engines.
- Demonstration of various RE devices such as biomass gasifier, briquetting plant, biogas power plant, etc. in the campus and meeting 100 per cent power requirement of the Institute using RE devices.
- Design, development and installation of biogas and solar based 5 TR Hybrid Vapour Absorption Refrigeration (HVAR) system for heating and cooling applications.
- Demonstration of solar thermal and photovoltaic systems.

The Institute has started scientific activities during the year 2010-11. Saplings of some of the oil-bearing trees were planted in the campus for increasing green cover and for producing raw materials for the R&D activities. In order to produce feed material for carrying out experiments on various bioenergy R&D and technology demonstration projects, 10,000 saplings of Jatropha Curcas were planted in about 3 hectares of the Institute and growth characteristics of the same are being monitored. The Institute has also planted 200 bamboo plants on the campus and 3000 forestry and oil-bearing plants have been planted along the boundary wall.

The R&D work has started on the MNRE sponsored 'Integrated Technology Development for Biodiesel Production using Heterogeneous Catalyst' project. The Secretary, MNRE and Chairman, Governing Council, SSS-NIRE, Shri Deepak Gupta inaugurated the Administrative Block of the Institute on 15 July 2011.



Research and Development laboratory, SSS-NIRE.



Small Hydro Power Boon to Rural Hilly Areas

It is quite difficult to provide electricity to people in remote locations and make a high return on capital. However, the Ramgad micro hydro project is a middle ground in which social welfare is being achieved along with profitability.

Vineet Mall

Renewable energy (RE) can play an important role in resolving the energy crisis in rural and urban areas to a great extent. RE today is an established sector with a variety of systems and devices available for meeting the energy demand of rural and urban inhabitants. Attempts have been made to generate grid-quality power through renewable sources.

Ramgad micro hydel project is situated in Betalghat block of Nainital district, on Nainital Almora Road in Uttarakhand. The scheme was commissioned in March 1990. A powerhouse building was constructed to house two units of turbine, a generator, oil pressure governor, butterfly (B/F) valve, control panel, battery and battery charger unit; 50 m of water head and 382 lt water per second discharge has been utilised for generation of 100 kW of power.

The power is generated at 415 volts and transmitted to the nearby villages at 11000 volts through a step-up transformer. The voltage transmitted at 11000 volts is again stepped down to 415 volts through step-down transformers erected at different village sub-stations. Five villages that have been electrified are Kafulta, Bargal, Garjoli, Jakh and Budhlagot.

Grid connection

Up to November 2004, there was no grid connection for the power generated by the project. Some of the problems at that time were: the villagers were misusing the power and did not care for it; the capacity was not fully utilised - the peak power reached 60 to 70 kW, while the average power was 30 to 40 kW; there was no supply of reliable and consistent power for agriculture e.g. during irrigation time; and the revenue generated was not covering even the operation and maintenance cost. It looked like this was not a profitable project.

On 24 November 2004, the project was connected to the grid for feeding the unusable power and taking from it at peak hours. A power purchase agreement (PPA) was signed between Uttarakhand Power Corporation Limited (UPCL) and Uttarakhand (then called Uttaranchal) Renewable

Energy Development Agency (UREDA) for selling or taking the power at the rate of Rs 1.64 per unit. The revenue generated is being distributed in the ratio of 75:25 between UREDA and the Village Urja Samiti.

The growth and development generated through the grid interconnection include:

- Community participation: The grid is being operated and maintained by the Village Urja Samiti; this has instilled a sense of equity participation and responsibility in the villagers.
- Revenue generation: The revenue generated was almost six lakh rupees, within two years only through grid connection.
- Sense of ownership: Before Grid connection, the villagers were misusing the power supply, but after the grid connection and minimum charge tariff along with metered supply, the villagers feel a sense of ownership and hence care for the electricity.
- Bridging finance: While going for grid connection, villagers submitted Rs 1000 each, which has made them financially attached to the utility.
- Government support: UREDA supports the Ramgad project for renovation and modernisation when required.

Specific global and local environmental benefits

The project will reduce estimated CO_2 emissions, while supplying electricity based on locally available hydro resources instead of relying on green house gas (GHG) emitting fuels. Further, the project demonstrates harnessing hydro potential in small rivers and encourages setting up of such new projects in future.

Financial analysis

Cost of the project is Rs 60,00,000. Unit energy cost paid by villagers is Rs 2 per unit. The payback period of the Ramgad project according to the calculations, comes out to be 3.74 year (for project with capital subsidy) and 6.81 year (for the project without subsidy).

Strength

Grid feeding has resulted in revenue collection and environmental benefits like flood control, irrigation, drinking water, soil erosion control etc. Employment has been generated for the villagers, e.g. formation of Urja Samiti. Currently there are 3 local people in charge of the small hydro power plant and each one of them is paid a salary of Rs 7000 per month by UREDA.

> **Grid feeding has resulted in revenue collection and environmental benefits like flood control, irrigation, drinking water, soil erosion control etc.**

Table 1: Excerpts of Interviews

Name of the house owner	Occupation	Income (Annual)	Electrical instruments in house
Kishan Singh Mehra	Farmer	Rs 10-12,000	TV; 4x60 W bulbs, Tape Recorder
Surendra Singh Pandey	Farmer	Rs 6-7,000	4x60 W bulbs, Tape Recorder
Narpath Singh	Clerk	Rs 24,000	TV; 4x60 W bulbs
Rajendra Singh	Farmer	Rs 12-14,000	2x60 W bulb
Deep Singh	Farmer	Rs 7-8,000	TV; 4x60 bulbs

Conclusion

In the present scenario, it is not possible to provide electricity to people in remote locations and make a high return on capital. Any project or financial investment is intended to make choices between two extremes, viz. profitability and social impact. However, this project - the Ramgad micro hydro project, is a middle ground in which social welfare is being achieved along with profitability.

The Project is serving around 300 low income households in addition to providing employment to the socially backward villagers. In fact, the cost of micro hydro is too high for marginalised people. Hence, in order to make the Ramgad project financially and economically viable a participative approach has been employed which is done by involving the community (Village Urja Samiti) in the process of project development. Investments made in the Ramgad project are primarily intended to promote social benefit for the villagers. With the recent growth and expansion, it has been possible to connect the Ramgad unit to the regional grid and the sale of surplus power to the grid has become possible, which has after a long wait made the Ramgad project financially viable. ✪

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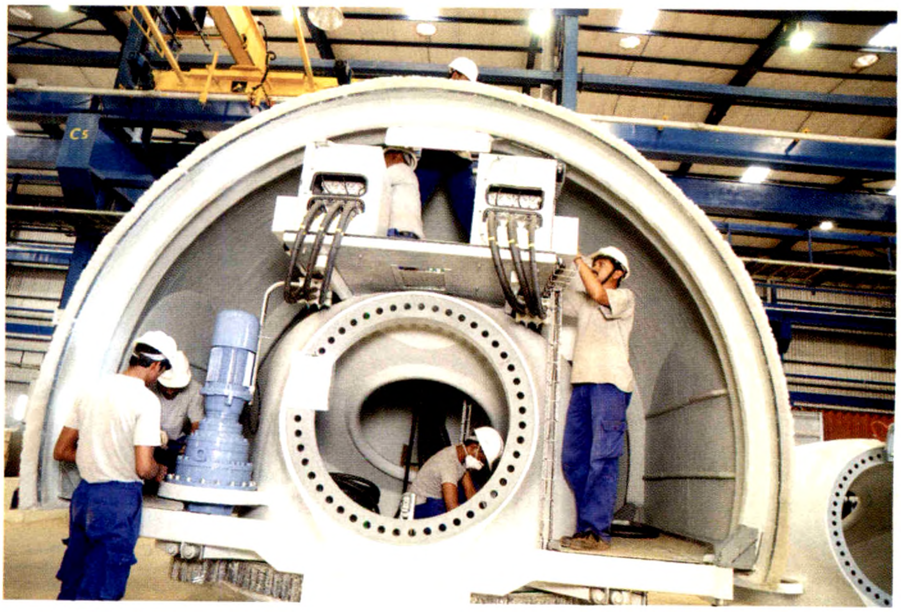
vineetmall4@gmail.com

Type Approval Provisional Scheme

TAPS 2000 (amended)

The Indian certification scheme for wind turbines, the 'Type Approval - Provisional Scheme' (TAPS) was formulated by the Standards and Certification (S&C) unit of the Centre for Wind Energy Technology (C-WET) in consultation with RISO National Laboratory (RISO), Denmark. The wind energy sector may avail this facility for provisional type testing (PTT) and provisional type certification (PTC) till the formation and issue of final Type Approval Scheme (TAS) and formal accreditation.

TAPS is intended to meet the requirements of manufacturers/ suppliers, wind farm developers, financial institutions, insurance companies, State Electricity Boards (SEBs), State Nodal Agencies (SNAs) and other related government /regulatory bodies.



According to TAPS-2000 (amended), the provisional type certification (PTC) of wind turbines can be carried out according to the following three categories:

Category-I: PTC for wind turbine already possessing type certificate or approval.

Category-II: PTC for wind turbine already possessing type certificate or approval, with minor modifications/changes, including provisional type testing/ measurements at the test site of C-WET/field.

Category-III: PTC for new or significantly modified wind turbine including provisional type testing/measurements at the test site of C-WET/field.

TAPS aims to promote procedures and requirements for the establishment of uniform codes, standards and technical criteria for design, manufacturing and operation of wind turbines.

TAPS will be applicable only to the grid connected, horizontal axis wind turbines of the rotor swept area greater than 40 sq m.

The procedures in TAPS have been formulated in consultations/ discussions with Indian Wind Turbine Manufacturer's Association (IWTMA).

Scope of TAPS

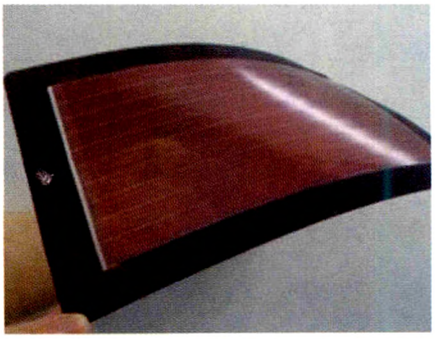
- TAPS covers the whole wind turbine up to and including wind turbine terminals and from the terminals to the grid.
- TAPS covers the whole process covering design, manufacturing and installation.
- Type certification for the design of the wind turbine is based on verification of documentation supplied by the wind turbine supplier, if necessary, supplemented by independent calculations, tests and surveillance inspections.
- Quality of the manufacturing and installation of wind turbines shall be ensured by review of the manufacturer's quality management systems (QMS), which shall preferably be certified for compliance with ISO 9001-2000.
- TAPS ensures compliance with the current safety requirements.

TAPS is issued by Ministry of New and Renewable Energy as a part of its guidelines to facilitate the wind energy sector.

The S&C unit of C-WET, which is the Type Certification Body, is the implementing agency of TAPS.

The certificate will normally be valid for a specified period of approximately 1 year; however, it can vary from case to case. ✪

Green energy future: spray on solar



Mitsubishi Chemical Corporation, Japan has developed a technology that enables solar cells to be applied to buildings, vehicles and even clothing in the same way that paint is applied. The new solar cells utilise carbon compounds, which, when dried and solidified, act as semiconductors and generate electricity in reaction to being exposed to light.

Mitsubishi Chemical is the first company to create the prototype spray-on solar cells, which at present have a practical conversion level of 10.1 per cent of light energy into electricity. That figure is still some way behind the 20 per cent that is standard in traditional crystalline silicon solar cells, but the firm expects to be able to improve the efficiency ratio to 15 per cent by 2015 and is aiming to eventually reach 20 per cent.

The sprayed-on solar cells are less than 1 mm thick - far thinner than existing solar cell technology - and weigh less than one-tenth of crystalline solar panels of the same size, the company said. Mitsubishi Chemical said it plans to work with domestic carmakers to build a car coated with the new solar cells with the aim of giving the vehicle sufficient power to travel 10 km after being exposed to sunlight for two hours.

www.independent.co.uk, 25 August 2011

Solio solar chargers

Solio is part of the Better Energy Systems Corporation, which creates hand held solar charging devices that store energy to be used in powering lights, smartphones, MP3 players, global positioning system (GPS) devices, digital cameras and handheld readers. The company produces items that are both highly portable and reliable.

It currently offers four products, including the Mono, the Rocsta, the Classic, and the Bolt. The Mono requires 20 hours of sunlight to fully charge, while the Rocsta requires 10 hours of sunlight, the Classic and Bolt require 9 hours. Their capabilities for charging devices vary from between 9 hours and 4.5 hours, depending on the type of device and the way it is being used. In addition, the products come with a carrying case and are USB compatible.

The new Solio Bolt can hold a charge for up to one year and can give most smartphones at least two or more complete charges. It easily connects to the USB charging cable that comes with most devices and makes it a breeze to stay in touch while on the go without continuously searching for wall plugs. In addition, the Bolt itself can be charged via the sun, a USB cord, or the wall, making it fully functional even at night or on a very overcast day.

www.solio.com, 10 August 2011

Solar window is 'green' game changer

The innovative product from Pythagoras Solar can be described as a solar window that combines energy efficiency, power generation and transparency. The transparent photovoltaic glass unit (PVGU) has been designed to easily integrate into conventional building design and construction processes. This means that existing office blocks can be retrofitted with the new material instead of energy seeping glass windows - a process that will pay itself back within five years. "What we have today - this is what we hear from architects - is very unique," said Pythagoras Solar CEO, Gonen Fink. He added, "The high transparency makes for aesthetically pleasing building designs. There are many companies today doing energy efficient windows or energy generators using photovoltaics such as skylights, but that is mostly to produce energy from the building' envelope. This is the first time somebody has actually combined the advantages in one product."

http://israel21c.org, 10 August 2011

How the wind blows...

Building the Anemometer

1. Cut off the cups' top lips.
2. Staple the cardboard strips together, forming a cross. Measure to make sure that each arm of the cross is the same length.
3. Staple each cup to the ends of the cardboard strips. Make sure that all cups, including the red cup, are facing the same direction. They will form a circle of cups when done.
4. Stick the centre of the cross to the top of the pencil eraser with a pin or tack.
5. Blow into the cups to make sure that they spin freely in wind. Adjust as needed so that they move easily.

Calculating the wind speed is a simple experiment that can be done with a few materials. This experiment will step you through making an anemometer and calculating the wind speed based on data collected.

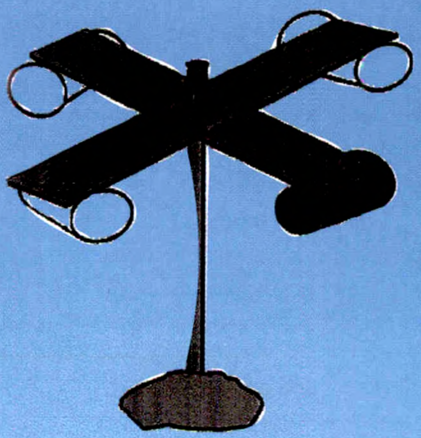
Calculating wind speed

- Take your anemometer out into the wind. Hold it above your head, but where you can still count the number of rotations.
- Count the red cup's rotations for 30 seconds.
- Multiply the number of rotations by the diameter of the anemometer in inches and divide by 168. This will give the wind speed in miles per hour.
- Multiply the number of rotations by the diameter in centimetres and divide by 265 to get the wind speed in kilometres per hour.

Things you will need

- Two 7-inch cardboard strips.
- Four paper cups, one coloured red
- Pin or tack
- A pencil with eraser
- Scissors
- Stopwatch
- Stapler
- Notebook
- Ruler

Source: www.ehow.com



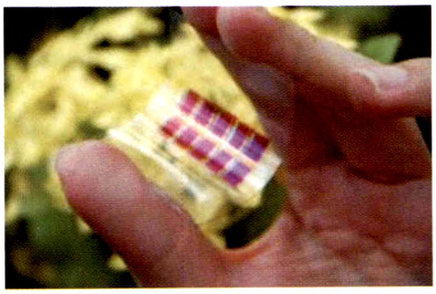
Make an anemometer and find out!

NEW POLYMERIC MATERIAL

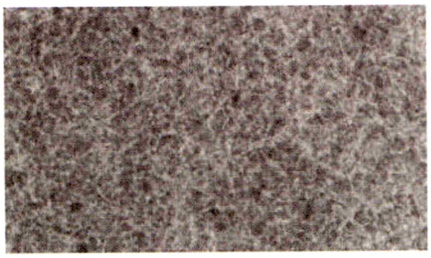
One step closer to cheaper plastic solar cells and electronics

Scientists from Singapore's Institute of Materials Research and Engineering (IMRE), an institute of the Agency for Science, Technology and Research (A*STAR) have created a new polymer with both high charge mobility and high power conversion efficiency for application in both plastic electronics and organic solar cells.

A single polymer that can be used in both new age plastic electronics as well as plastic solar cells could spell greater cost savings and open up new design options for electronic and solar cell companies. A*STAR's IMRE has developed a new polymer that not only produces a high charge mobility of 0.2 sq cm per statvolt's, which is the same value achieved by commercially available semiconducting materials but also has a high solar power conversion efficiency of 6.3 per cent. This makes IMRE's polymer one of the few that has both these properties. In addition to this, polymers of the same class as IMRE's, which are those that use thiophene and benzothiadiazole as the building blocks, could only achieve 2.2 per cent power conversion.



Flexible, organic solar cells - IMRE's polymer can help save costs and resources in making devices like organic solar cells and next generation printed circuits on plastic.



A transmission electron microscopy image of the IMRE polymer, PC71BM film, showing phase separation between the polymer fibres (light) and PC71BM (dark). Credit: Agency for Science, Technology and Research (A*STAR)

"Current polymers are usually good in one aspect or another, either as a good conductor for use in electronics or endowed with high power conversion efficiency - but not both", said IMRE Senior Scientist, Dr Chen Zhi Kuan, the principal researcher working on the polymers. "IMRE's polymer functions not only as a good material to make electronic components, the same material can be used to convert sunlight to electricity efficiently". The polymer can also be easily applied in roll-to-roll printing techniques which is similar to how newspapers are currently printed making it possible to manufacture large area scale printed electronics and organic solar cells quickly and cheaply.

With IMRE's polymer, manufacturers could save cost using just a single bulk resource for making both printed electronics and organic solar cells. The material could also possibly be used in designing new devices where both power harnessing and electronics are needed in a single component. An example of this would be chemical sensors based on organic thin film transistors and powered by organic solar cells.

"This breakthrough will help speed up the development of plastic electronics and organic solar cells, and make them more readily available in the marketplace," said Prof Andy Hor, Executive Director of IMRE.

Printed electronics often rely on organic materials like polymers that can be easily processed and manufactured as opposed to traditional electronics (or metal electronics) which rely on inorganics such as copper or silicon. The polymers can be made into thinner, lighter and cost-effective electronic components and organic solar cells.

The IMRE team is developing other organic materials-based polymers that can be scaled up to production and integrated easily into organic electronics. These materials can be used to make energy harvesting and low-power consumption devices like low-cost organic solar cells, new flexible display devices, next generation smart labels and RFID tags.

The research and results were recently published in the Advanced Materials journal and online at the Nature Publishing Group (NPG) Asia Materials in July 2011.

Forthcoming Events

National

12 November 2011	National Conference on Challenges in Power System Operation and Control Place: Jaipur, Rajasthan Organiser: Sri Balaji College of Engineering and Technology, Jaipur Contact: (91) 93092 51728 or nccpsoc.2011@ieee.org Website: http://cpsoc2011.webs.com
14 - 15 November 2011	Smart Energy Internal - India Place: New Delhi Organiser: Spintelligent Contact: (91) 99669 50931 or aditya.jammi@spintelligent.com Website: www.smartenergy-india.com
18 November 2011	India Unconventional Gas Forum (IUGF) 2011 Place: Mumbai, Maharashtra Organiser: Oil and Maritime Contact: (22) 402 1305 or mohit@aaships.com Website: www.oilnmaritime.com
1 - 3 December 2011	Energy Expo 2011, Place: Ahmedabad, Gujarat Organiser: Confederation of Indian Industry (CII) Contact: (22) 2493 1790 or romaldine@ayire@cii.in Website: www.ese.iitb.ac.in
9 - 11 December 2011	International Conference on Advances in Energy Research Place: Mumbai, Maharashtra Organiser: Indian Institute of Technology Bombay Contact: (22) 2576 7890 Website: www.ese.iitb.ac.in
13 - 16 December 2011	Intersolar India Place: Mumbai, Maharashtra Organiser: MMI India Pvt Ltd. / Solar Promotion International GmbH / Freiburg Management and Marketing International GmbH (FMMI) Contact: (22) 4255 4707 Website: www.intersolar.in

International

10 - 11 November 2011	St. Gallen International Energy Forum (IEF) Place: St. Gallen, Switzerland Organiser: University of St. Gallen Contact: 41 (0) 71 224 2866 or europarecht@unisg.ch Website: www.sg-ief.com
16 - 17 November 2011	Biofuels International Expo and Conference Place: Antwerp, Belgium Organiser: Biofuels International Contact: 44 (0) 20 8687 4138 or rebecca@horseshoemedia.com Website: www.biofuelsinternationalexpo.com
22 - 23 November 2011	World Energy Investment forum 2011 Place: Berlin, Germany Organiser: Fleming Europe Contact: 421 257 272 118 or alexandra.spirova@flemingeurope.com Website: http://energy.flemingeurope.com
23 - 25 November 2011	4th International Conference on Sustainable Energy and Environment (SEE 2011) Place: Bangkok, Indonesia Organiser: SEE Forum International Contact: (66) 028729014 or see2011@jgsee.kmutt.ac.th Website: www.4th-see.com
6 - 9 December 2011	Intersolar China Place: Beijing, China Organiser: Solar Promotion International GmbH / Freiburg Management and Marketing International GmbH / MMI (Shanghai) Co., Ltd. Contact: 49 7231 58598-207 Website: www.intersolarchina.com

National

International

Website

Centre For Wind Energy Technology (C-WET)

www.cwet.tn.nic.in

To sustain wind energy development and to help India achieve self reliance in the power sector, Ministry of New and Renewable Energy (MNRE) has been planning and developing the basic infrastructure, institutions, and resources for carrying out research and development, large scale demonstration and diffusion of the non conventional energy sources. As a step towards achieving these broad goals and to tackle the challenges in sustaining the development and accelerating the pace of utilisation of wind energy in the country the C-WET was established by MNRE at Chennai as an autonomous R&D institution of Government of India.

The Indian Wind Energy Association (InWEA)

www.inwea.org

InWea set up in 2002, with more than 300 members is dedicated to promotion and development of wind power in India. Since its inception InWEA has worked consistently towards removing barriers to wind power development and creation of an enabling regulatory and policy environment for investments in this sector.

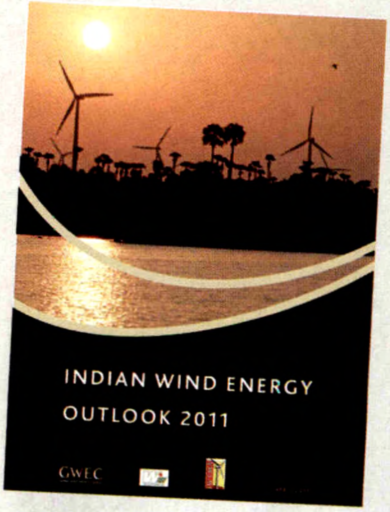
www.wisein.org

World Institute of Sustainable Energy (WISE)

The need to create an institution that would play a holistic and critical role in shaping an energy secure and sustainable future gave rise to the establishment of the WISE in June 2004.

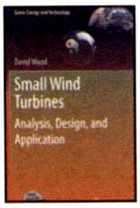
Forthcoming release

Indian Wind Energy Outlook 2011



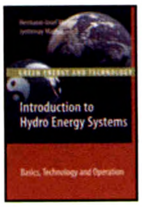
The Indian Wind Energy Outlook 2011 is a joint publication by Global Wind Energy Council (GWEC), World Institute of Sustainable Energy (WISE) and Indian Wind Turbine Manufacturers Association (IWTMA). The report examines the current status of wind power development in India, discusses the policy environment for wind, and assesses the potential for future growth, and highlights the economic, environmental and energy security benefits. It pinpoints remaining obstacles which need to be overcome for India to fully exploit its rich wind resource.

The report is available on www.gwec.net



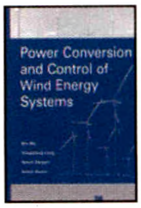
Small Wind Turbines

by **Wood, David**
Hardcover: 270 pages
Euro 129.95
Publisher: Springer 2011
ISBN: 978-1-84996-174-5



Introduction to Hydro Energy Systems

A report by RNCOS
65 pages
CD-ROM mail delivery: USD 700
Hard copy mail delivery USD 700
Electronic access - Single user license: USD 600
Electronic access - Multi user license: USD 900
Publisher: RNCOS, June 2011

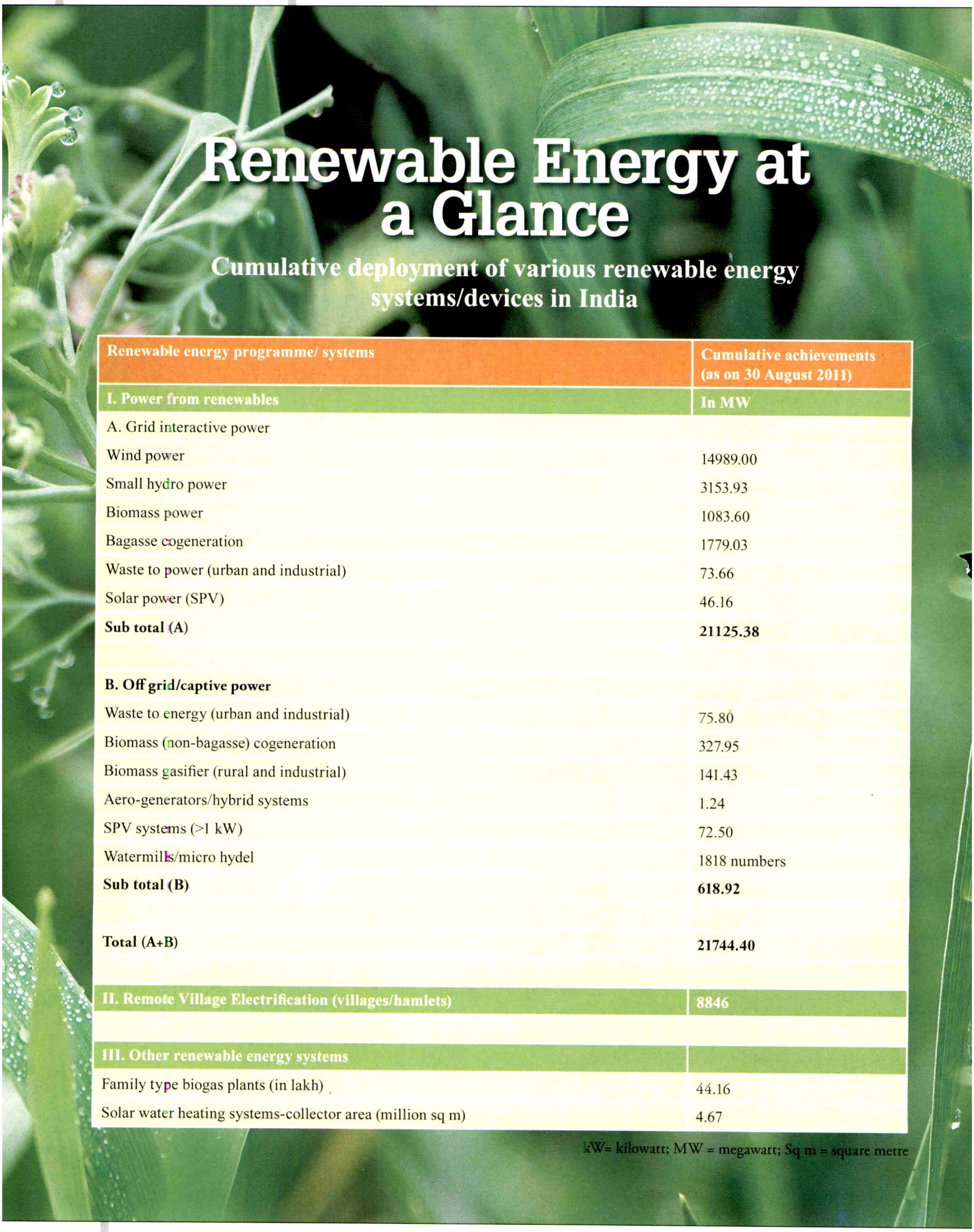


Power Conversion and Control of Wind Energy Systems

by **Bin Wu, Yongqiang Lang, Navid Zargari, Samir Kouro**
Hardcover: 480 pages
USD 110.00
Publisher: Wiley-IEEE Press August 2011
ISBN: 978-0-470-59365-3

Wind Energy International 2011/12

Paperback: 460 pages
Euro 98.00
Publisher: WWEA - World Wind Energy Association, Bonn 2011
ISBN: 978-3-940683-02-3



Renewable Energy at a Glance

Cumulative deployment of various renewable energy systems/devices in India

Renewable energy programme/ systems	Cumulative achievements (as on 30 August 2011)
I. Power from renewables	**In MW**
A. Grid interactive power	
Wind power	14989.00
Small hydro power	3153.93
Biomass power	1083.60
Bagasse cogeneration	1779.03
Waste to power (urban and industrial)	73.66
Solar power (SPV)	46.16
Sub total (A)	**21125.38**
B. Off grid/captive power	
Waste to energy (urban and industrial)	75.80
Biomass (non-bagasse) cogeneration	327.95
Biomass gasifier (rural and industrial)	141.43
Aero-generators/hybrid systems	1.24
SPV systems (>1 kW)	72.50
Watermills/micro hydel	1818 numbers
Sub total (B)	**618.92**
Total (A+B)	**21744.40**
II. Remote Village Electrification (villages/hamlets)	**8846**
III. Other renewable energy systems	
Family type biogas plants (in lakh)	44.16
Solar water heating systems-collector area (million sq m)	4.67

kW= kilowatt; MW = megawatt; Sq m = square metre

Volume 5 ■ Issue 3 ■ December 2011

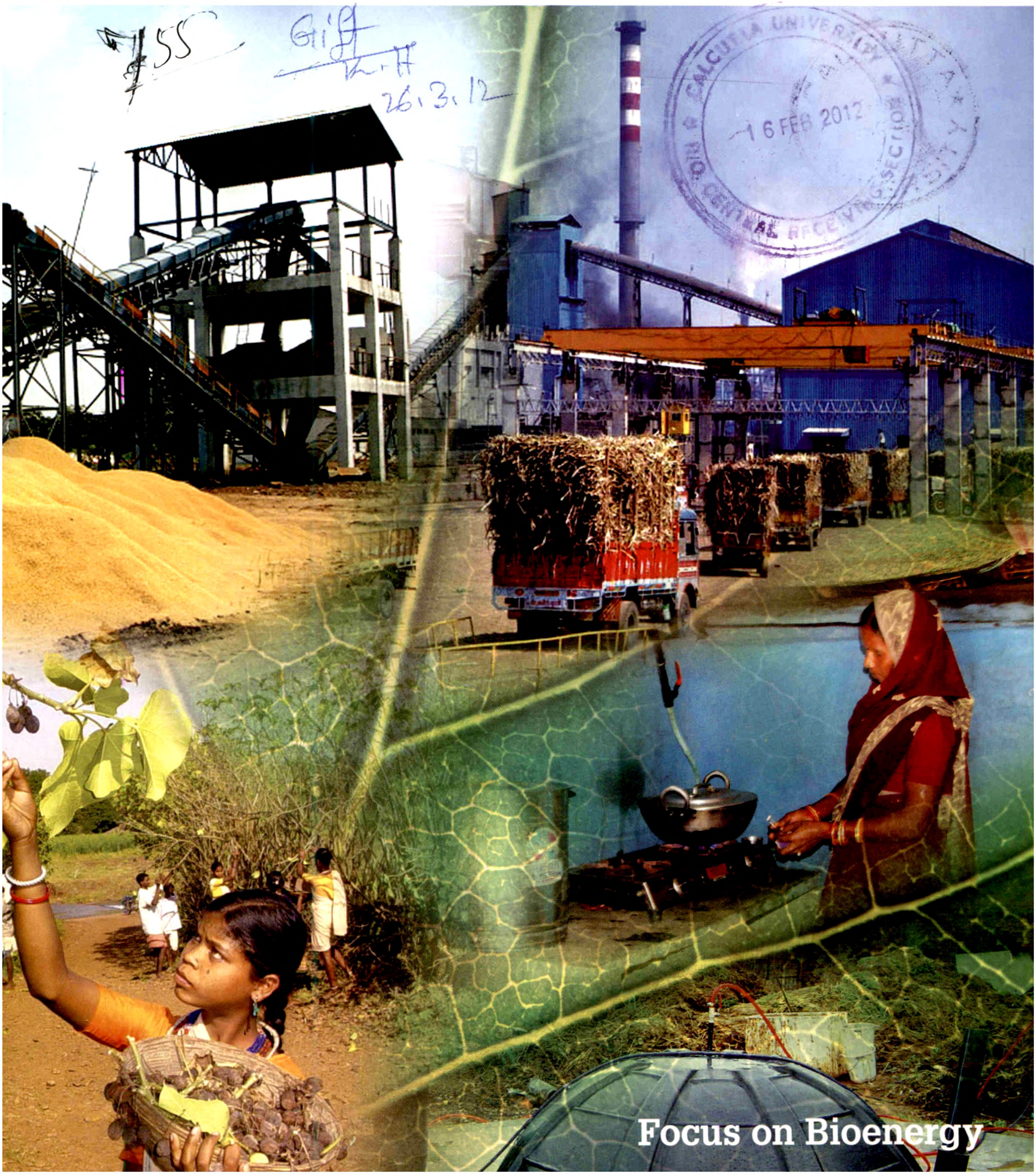
सत्यमेव जयते

nistry of New and
enewable Energy
overnment of India

Renewable Energy

Akshay Urja

www.mnre.gov.in



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Renewable Energy
Akshay Urja

Volume 5 ▪ Issue 3
December 2011

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(Published in English and Hindi)

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Cover Photo: A glimpse of Bioenergy utilisation in India.

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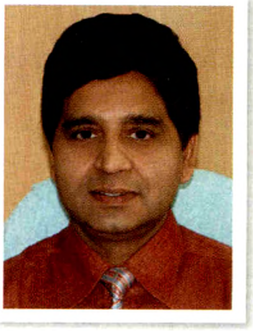
From the Editor's Desk

Dear Readers,



Biomass comprises of organic matter encompassing all forms of living or non-living matter derived from biological activities, broadly classified into two categories - terrestrial (organic residues, tree, plants, etc.) and aquatic (plants, seaweeds, sea grass, micro algae, floating marine plants, coral reefs and salt-tolerant species).

Biomass is renewable and commonly available. The most accessible and easily obtainable biomass resource comes from the terrestrial component, comprising of wood, sawdust, agricultural residues (rice husk, bagasse, groundnut shells, coconut shells, molasses, maize cobs, cotton stalks, jute and mesta sticks, arhar stalks, maize stalks, mustard stalks, and straw), forestry residues (bark, chips, shavings and leaves), human and animal waste (human excreta and cattle dung), municipal solid waste, sewage sludge, and industrial waste, among others. This makes it a convenient source of energy in rural areas. Currently, it has been estimated that about 11 per cent of the world's primary energy is met using biomass. In India, about 32 per cent of the total primary energy use is derived from biomass and over 70 per cent of the country's population is still dependent on it for its energy needs. Biomass can be converted into solid, liquid and gaseous forms depending upon the source, requirement and application.

The Ministry of New and Renewable Energy is implementing a wide range of programmes for promotion of biomass based energy derived from various conversion technologies i.e. biogas generation, biomass gasification, biomass combustion, pyrolysis, biomass densification etc. in the country for the last 25 years. Utilisation of bagasse through cogeneration in sugar mills is also a successful development. Over 3000 MW biomass-based power plants have been set up in India.

In this context the present issue highlights the role of bioenergy in shaping the future of our nation. The articles cover a wide range showcasing various new technologies, present status and success stories. The article on Biomass Power in India - An Overview, provides a comprehensive treatise on the development of biomass power and its utilisation in the country. I am sure the present issue will find appreciation among our young and senior readers.

Best wishes for the forthcoming new year 2012.

अक्षय ऊर्जा से देश विकास

ARUN K TRIPATHI
<aktripathi@nic.in>

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Letters to the Editor

I am pleased to know that MNRE brings out an important and very informative newsletter Akshay Urja through which our students and faculty members can know the value of energy conservation and renewable energy sources.

Prof M Lalwani,
Dean (Admin.), Pinkcity
Engineering College and Research
Centre, Jaipur, Rajasthan.

Let me congratulate you for the last issue of Akshay Urja (Wind Power in India). It appears that a lot of effort and commitment has been put in to publish it. The quality of the articles, pictures, news items and the presentation are exemplary. It is a fact that technical magazines have a double role to play, first to entertain the reader and second to provide the latest information in a simple and lucid manner. I find Akshay Urja fulfilling both the criteria very well. It is heartening to see an article from a student in the issue; it will certainly give a boost to the student community. I wish Akshay Urja and its team a great success.

Sanjay Prakash,
sanjay_prksh@yahoo.co.in

I had a chance to go through your magazine Akshay Urja and feel that it is very useful to make renewable energy popular among 'aam admi' (the common person). With growing pollution and frequent power cuts and load shedding renewable energy is the need of the hour. It is becoming popular in rural areas where electricity has not reached, especially for charging mobile phones. I would like to extend my best wishes to you for a wonderful job.

Shambhu Sharan Sharma,
Nalanda, Bihar

I completely agree with the opinion put forth in the October 2011 issue of Akshay Urja that renewable energy is no longer 'alternative' energy. Conventional energy resources are depleting rapidly and we have to search for alternative energy sources that are clean, green and sustainable. It is the only magazine, which is available to all sections of the society and it is doing a good job of publicising renewable energy and making renewable products popular.

Vishal Juneja,
Noida, Uttar Pradesh

I am interested in working with renewable energy sources for which I find Akshay Urja magazine very fruitful for acquiring knowledge in this respect.

Mahendra Singh Poonia,
Kolkata, West Bengal

This is to humbly request you that our school shall be interested to receive the bi-monthly newsletter - Akshya Urja for the larger benefits of students and teachers so that they can get a first hand knowledge of alternative options of energy sources. The depleting energy resources need to be known by one and all for which a school is the best platform.

The Principal
Shri Ajit Vidya Mandir
Sr. Secondary School,
Shanti Nagar,
Sirohi, Rajasthan

मै विकेश कुमार सिह, काशी हिंदू विश्व विद्यालय का छात्र हूँ। मुझे 'अक्षय ऊर्जा' पत्रिका के चौथे वर्ष का अंक (फरवरी, 2011) अपने मित्र उत्पलकांत की सहायता से प्राप्त हुआ। इसमें दी गई जानकारियाँ व लेख सद्पयोगी एवं सहर्ष स्वीकार्य हैं। इस पत्रिका में संदर्भित जानकारियां मैंने अन्य छात्रों तक भी पहुँचाई, जिन्होंने इसे काफी पसंद किया। अतः संपादक महोदय से नम्र निवेदन है कि इस तरह की जानकारियाँ हमेशा प्रकाशित करते रहें ताकि हम सभी नवीकरणीय ऊर्जा के विकास में स्वयं की भूमिका को स्पष्ट कर देश को प्रगति पथ पर अग्रसर कर सकें।

विकेश कुमार सिंह,
नरेन्द्र देव छात्रावास,
वाराणसी, उत्तर प्रदेश

अक्षय ऊर्जा पढ़कर बहुत प्रसन्नता हुई। अक्षय ऊर्जा अपने घर पर प्रति माह प्राप्त करने हेतु सदस्य बनना चाहता हूँ। अतः आपसे आग्रह है कि मुझे विस्तृत जानकारी फार्म के साथ भेजने की कृपा की जाए। बी.एस.सी. (मैथ) से स्नातक कर रहा हूँ, तथा अक्षय ऊर्जा के क्षेत्र में तकनीकी कोर्स का डिप्लोमा या कोई प्रशिक्षण दिया जा रहा है तो कृपया मुझे बताने का कष्ट करें।

कमलेश देशमुख,
पिता–महादेवराव देशमुख,
सोमवारी चौक, जैन मोहल्ला अमला,
जिला–बेतुल, मध्य प्रदेश

Dear Reader, Thank you very much for your encouragement. The editorial team of Akshay Urja will make every effort to make this newsletter highly informative and useful to all our readers. We welcome your suggestions and valuable comments to make further improvements in terms of content and presentation. **Editor: Akshay Urja**

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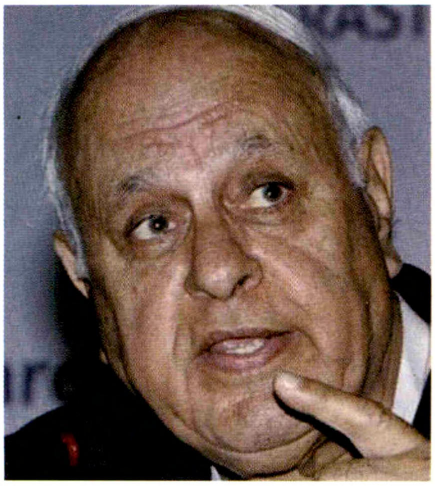
A wide variety of cook stoves have been developed worldwide for combustion or gasification of biomass and these burn the fuel 2-3 times more efficiently than the traditional stoves.

The biodiesel production efforts in India are focused on using non-edible oils from plants (*Jatropha curcas, Pongamia pinnata* and other tree borne oilseeds) and animal fats like fish oil.

The sewage treatment plants (STPs) of Surat Municipal Corporation are set up on the Conventional Activated Sludge process and gas is generated by the process of anaerobic digestion.

National Bio Energy Mission soon



A National Bio Energy Mission is being developed to push sustainable development of the renewable energy (RE) sector, said Dr Farooq Abdullah, Union Minister for New and Renewable Energy, while addressing the Bio Energy Summit organised by Confederation of Indian Industries (CII). Mr G B Pradhan, Secretary, MNRE, said the most critical aspect in promoting bio energy projects was the associated business model, which should be sustainable. Mr K Krishnan, Chairman, CII Task Force on bio energy, pointed to hybrid solutions that combine bio energy with solar, wind and hydro as promising sustainable solutions. The CII recommended rationalising the pricing of fuels and tariffs to reflect the economic cost of supply, reducing cross subsidies and flexibility to capture changing fuel prices in a competitive market.

www.thehindubusinessline.com, 29 November 2011

Solar Mission: Bidders quote historic low prices

French solar power developer Solairedirect created history by bidding for a 5 MW solar project quoting a tariff of Rs 7.49 a unit, bringing electricity from sun's energy closer to the reach of the common man. Solairedirect's tariff has stunned many in the industry despite the fact that it was generally expected that solar power developers would quote low tariffs in order to grab projects under the Batch II of Phase I of the National Solar Mission. In this round, bids were invited for 350 MW worth of projects. The quotes were arranged in the ascending order, so that those who sell the power cheapest will be given the projects first. The allocation process stopped when the total capacity of projects allocated reached 350 MW. More than 180 project developers submitted bids, indicating a keen interest in the Indian solar sector. The bids were handled by NTPC Vidyut Vyapar Nigam Ltd (NVVN), the power trading arm of NTPC, which has been nominated by the Government to handle the Phase-I of the Solar Mission.

www.thehindubusinessline.com, 2 December 2011

CERC sets up fund to promote RE projects

The Central Electricity Regulatory Commission (CERC) has set up a renewable energy fund (REF) to promote projects in India. This fund is aimed at compensating states if they fail to meet the target given under their schedule of RE projects. All RE projects are required to provide a schedule of generation to CERC from 2012. Officials explained that REF would bear charges imposed on states hosting RE projects that fail to comply with their supply commitments. At present, only wind energy projects without sale arrangements with states are required to give declarations forecasting their generation to state load despatch centres. CERC allows 30 per cent deviation in the supply commitments, beyond which penalties are levied or incentives offered.

www.business-standard.co, 26 November 2011

Making ice in the desert with solar power

A digital art impression shows a solar panel installation in the desert with ice making capabilities. It is designed like a leaf, nature's master at absorbing the sun's energy, and has solar cells covering its 200 sq m. Under the face of the elm leaf shape structure are cooling condensers that soak up humidity from the desert air. Even in the hottest conditions, it will produce a layer of ice on the leaf's ridged underside.

http://epaper.timesofindia.com, 25 October 2011

Private equity investments in clean tech projects on the rise

With government policies and incentives in place for RE, the number of private equity investments in the clean technologies sector is increasing. According to data from Venture Intelligence, a research service focused on private equity and merger and acquisitions, there were 5 deals in the clean technologies space in the January-March 2011 quarter; 10 in the April-June 2011 quarter and 14 deals in the July-September 2011 quarter. The amount invested in the July-September quarter was USD 359 million compared with USD 176 million in the immediate previous quarter.

Although the clean technologies space is still nascent, investors say that the sector looks attractive and could see a lot of growth. "A lot of firms are investing in wind energy projects. It is difficult to get investment for solar projects as subsidies are uncertain," said Mr Avinash Gupta, Leader, Financial Advisory, Deloitte in India. Exits in the clean technology sector are difficult; investors usually exit after 4–6 years, say private equity investors.

www.thehindubusinessline.com, 18 October 2011

India and British Columbia to extend cooperation in the field of RE

Ms Christy Clark, Premier of British Columbia, Canada met Dr Farooq Abdullah, Minister of New and Renewable Energy in New Delhi and held detailed discussions on cooperation between India and British Columbia in the field of RE. Both the Ministers were accompanied by high level delegations. Dr Abdullah gave an overview of the progress made by India in different fields of RE. It was observed that India has already signed an umbrella memorandum of understanding (MoU) with Canada in the field of energy including RE and it was agreed that the two sides would explore cooperation between institutions of repute in India and British Columbia in identified fields. Fuel cells, storage batteries, bio energy and small hydro programmes were identified as possible areas of cooperation.

http://pib.nic.in, 18 November 2011

India and UK agree to set up partnership fund for pro-poor renewables on priority basis

Minister of State for Energy and Climate Change of UK, Mr Greg Barker met Minister of New and Renewable Energy Dr Farooq Abdullah in New Delhi. There was detailed discussion between the two sides on cooperation in the field of RE. Dr Abdullah explained various initiatives being taken by India in the field of RE in urban as well as rural areas.

Both the Ministers agreed that the proposed Partnership Fund for pro-poor renewables should be set up on priority basis to scale up installation of RE technology in a cost effective and efficient manner. The visiting Minister emphasised on the need for private investment in addition to Government funds to promote renewables. He also suggested that India should consider tapping funding from Capital Market Climate Initiative by proposing MW scale pilot projects. Dr Abdullah suggested certain MW scale solar hybrid pilot projects and thanked the UK for providing technical support for the proposed Bio Energy Mission and requested continued support as and when the Mission becomes operational.

http://pib.nic.in, 15 November 2011

Illumination Laboratory foundation stone laid

Energy Efficiency and Renewable Energy Division of the Central Power Research Institute (CPRI) has undertaken the establishment of facilities for evaluation of solar powered and grid powered LED lamps and lanterns. The foundation stone laying for the Illumination laboratory for the LED evaluation was conducted on 2 November 2011. Shri Gireesh Pradhan, Secretary, MNRE, inaugurated this laboratory and interacted with the senior officers. Dr Bibek Bandyopadhyay, Advisor, MNRE and Director Solar Energy Centre was also present on the occasion. Speaking on the occasion Shri Murugesan, Director General CPRI assured the Secretary that the laboratory would be functional by the end of this financial year.

www.mnre.gov.in

GE's big wind turbines enter Indian market

GE Energy Financial Services will invest USD 50 million in a new USD 115 million venture to develop wind power in India. GE will support the development of 500 MW of India based Greenko Group's 1000 MW of planned wind projects across 4 Indian states. Once operational, a 500 MW wind portfolio could generate enough renewable electricity to power 8,75,000 average Indian households. Formed in 2006, Greenko operates 183 MW of energy capacity across India, including 7 hydroelectric power plants, 6 biomass plants and 1 gas/liquid fuel based plant, with 1600 MW of projects under development, including 1000 MW of wind power. Wind projects under the Greenko Wind Project Private Limited joint venture will be developed in the Indian states of Maharashtra, Andhra Pradesh, Karnataka and Rajasthan. The first project, the 65 MW Ratnagiri wind power plant in Maharashtra, is scheduled for completion by the end of the year. The plant will use 1.6 MW turbines – specifically designed for low and medium wind speeds – that will be assembled at GE's facility in Pune.

www.earthtechling.com,
25 October 2011

Power company to set up solar energy plant

In a bid to popularise environment friendly energy sources, Noida Power Company Limited (NPCL) is going to build a 1 MW solar power plant and distribute the power generated through women self help groups (SHGs). The company is setting up the solar power plant near its substation in Surajpur in Greater Noida. It is simultaneously developing the SHGs through a separate programme in association with a Delhi-based NGO, Development Initiatives. Electricity from the solar power plant would help the company meet its target of procuring at least 4 per cent of total energy purchased from renewable sources as per the mandate set out by MNRE. In subsequent phases, NPCL would engage in community distribution of solar power through women SHGs. The MNRE provides a flat rebate of around 28-30 per cent for setting up these systems. After discount, each system would cost around Rs 22 lakh to the company.

http://timesofindia.indiatimes.com,
29 October 2011

India establishes world's first national helpline for solar water heaters

MNRE has established a voice-activated national helpline on solar thermal water heaters to raise awareness about the technology and to answer questions of the consumers. The move by the Ministry is part of the initiative of the UNDP/GEF Global Solar Water Heating Project (GSWHP). The helpline has been operating since 15 September 2011, and is managed by the Solar Thermal Federation of India. The helpline offers a toll-free number (1800 2 33 44 77), with service hours between 9:30 and to 6:00 pm, from Monday to Friday, and 9:30 am to 1:30 pm on Saturdays. The call centre agents offer help in both Hindi and English. Manufacturers can pay a small fee to be registered with the call centre and attract clients to their network of dealers and installers. MNRE allows only manufacturers, which have been approved as channel partners to take part in the national incentive programme. In addition, the helpline will help better disseminate information about the benefits of solar water heaters, as well as information about incentives and financing related to solar thermal technology use.

www.solarserver.com,
18 October 2011

Dr Farooq Abdullah expresses concern over diminishing resources of energy

Highlighting the importance of energy in our day to day life, Union Minister for New and Renewable Energy, Dr Farooq Abdullah expressed his concern over the diminishing resources of energy. Addressing the 'ninth edition of Green Building Congress 2011', Dr Abdullah said that 40 per cent of Indian population still depends upon primitive means of energy sources. He added that the government is taking initiatives to provide energy by making use of renewable sources.

www.newstrackindia.com,
20 October 2011

400 companies register for REC

More than 400 companies situated in the northern region comprising

Punjab, Haryana and Rajasthan have registered themselves with renewable energy certificate (REC) registry of India under open access category to purchase RECs. According to the data, about 300 companies from Punjab, 70 from Rajasthan and 30 companies from Haryana have registered themselves. In March 2011, 240 RECs were sold on Indian Energy Exchange platform while in September, the volume reached 41,000 RECs. According to the Central Electricity Regulatory Commission (CERC) regulations, two types of certificates would be issued - solar and non-solar. The solar certificates will be given to those who would generate solar power, while the non-solar certificates are meant for companies generating electricity from other RE sources like wind and hydro.

http://business-standard.com,
5 October 2011

Sugar mills body wants Government to finalise ethanol pricing policy

The Indian Sugar Mills Association (ISMA) has urged the Government to revise the provisional ethanol price of Rs 27/lt fixed in August 2010 and consider a clear pricing policy so that the sugar companies can plan their investment to enhance ethanol production. An expert committee under the Chairmanship of Dr Saumitra Chaudhuri, Member, Planning Commission, in March 2011 recommended that ethanol should be priced 20 per cent lower than the petrol price without including the taxes. "The uncertainty in ethanol pricing has hit the sugar industry which paid Rs 50,000 crore to farmers for their sugarcane. Given the bumper crop this sugar season, the payment will increase to Rs 60,000 crore, much higher than the Government sponsored NREGA scheme," he added. The country has an installed capacity of over 200 crore litres of ethanol which is sufficient to meet the mandatory five per cent blending programme. A final pricing policy of ethanol would ensure more ethanol manufacturers come forward for supply of additional quantities.

www.thehindubusinessline.com,
16 October 2011

CREDA honoured with India Power Award 2011

Electricity Producers Council, a leading NGO, awards organisations at the national level for their outstanding contribution in the field of energy, RE and energy conservation every year. This year the award was presented to Chhattisgarh Renewable Energy Development Agency (CREDA) by Dr C Rangarajan, Ex-Governor of Andhra Pradesh and currently National Economic Advisor to the Prime Minster, on 24 November 2011 in New Delhi for their outstanding work in providing electricity through non-conventional energy sources and helping in social and community development in rural areas. CREDA has been instrumental in electrifying 1397 remote electricity-less villages during the last 8 years. The established systems are operating successfully and about 58,525 stakeholders are being benefitted. Besides, CREDA has helped in lighting 1756 tribal ashrams/community centres through solar energy. Shri Shailendra Kumar Shukla, Director, CREDA received the prestigious award.

http://www.credacg.org

MNRE encourages the use of Hindi

Dr. Farooq Abdullah, the Union Minister for New and Renewable Energy, presided over the meeting of the Hindi Advisory Committee of the Ministry of New and Renewable Energy on the 20th December, 2011 in New Delhi, which was attended by the Members of the Committee and senior officers of the Ministry.

The participants discussed in detail issues such as the usage of Hindi in official correspondence, effective implementation of Official Language Policy, the purchase of Hindi books, encouraging officers and workers to work in Hindi, organizing Hindi workshops etc. The Members of the Committee appreciated the efforts made by the Ministry in order to implement the official language policy and expressed satisfaction in that regard.

www.mnre.gov.in

Boeing and Embraer invest in Brazilian biofuels research

Plane maker Boeing and commercial jet manufacturer Embraer have formed a collaboration with Sao Paulo State Research Foundation (FAPESP) for research to be conducted in aviation biofuels. The companies plan to work together to research and write a report, due to be published at the end of next year, which will include information on a new technology and sustainability roadmap. The report will outline the challenges of producing jet fuels in a cost effective and sustainable manner, by producing bio derived fuels. Boeing and Embraer are set on developing biofuels that are not derived from food or come from areas where land and water are scarce. The companies will work with agriculture, academic, environmental, refinery and aerospace groups to define the best ways to launch the development.

www.biofuels-news.com,
27 October 2011

WEF report highlights retrofit market as key to green growth

A report entitled, 'A Profitable and Resource Efficient Future: Catalysing Retrofit Finance and Investing in Commercial Real Estate', describes the critical role that banks, insurance companies, institutional investors, utilities, energy service companies and real estate holders need to play in unlocking the potential of the retrofit market, which has been estimated at USD 400 billion in the United States of America (USA) alone. Among the six countries the report looks at in-depth, Australia was found to have the most mature retrofit market as a result of a long standing reporting and rating system, coupled with additional government led action, including tax deductions and a third party institution to take on demonstration projects. Other markets examined included China, Japan, USA, United Kingdom and Germany. "This report offers a clear set of actions for policy makers and industry, starting now, making the low carbon economy a reality for all our futures", said Chris Luebkeman, Director, Global Foresight and Innovation, Arup Group.

www.renewableenergymagazine.com,
27 October 2011

Dongfang clears India export hurdle with 1.5 MW quality mark

Dongfang Electric is one of the first manufacturers from China to get a Type certificate based on international guidelines set by technical standards body Germanischer Lloyd (GL) for design, testing and manufacturing. Meeting the guidelines is widely recognised by financiers and wind farm operators as a guarantee of turbine quality. For the firm, the certificate – issued by German testing agency TUV Sud – is crucial to completing its entry into the Indian market. Last year the firm signed a USD 203 million contract with Indian developer KSK Energy Ventures to supply 166 of its 1.5 MW turbines. However, it has not delivered any yet because of India's requirements that turbines are tested and certified by the country's Centre for Wind Energy Technology (CWET) or another international testing institute. The company will still need to fulfil a second condition of local manufacturing before it can ship any turbines in to the country.

www.rechargenews.com,
25 October 2011

Mission achieves the world's first Jatropha ISCC certification

Mission NewEnergy Limited (MNEL), one of the world's largest Jatropha plantation companies announced that it has received the coveted International Sustainability and Carbon Certification (ISCC) for its Jatropha contract farming model, a world first for any Jatropha business. To qualify for ISCC certification, companies must meet strict criteria for sustainable production, as well as reduced emissions of greenhouse gases (GHGs). The ISCC was developed to certify that biofuels, and biomass for biofuels are produced in compliance with recent European Union (EU) legislation that requires all biofuels and biomass to be certified according to the European Union Regional Economic Development programme (EU-RED) requirements.

As part of this pilot certification process, a selection of Mission's Jatropha contract farmers in India underwent intensive audits to evaluate the sustainability of their farming practices and processes, as well as traceability of product produced within the supply chain. With this pilot certification, Mission can continue to obtain certification for its entire contract farming operation. 'We believe that this certification, achieved with the assistance of our proprietary Mission Agro Technology (MAT) platform, creates a benchmark for the Jatropha industry to meet the highest standards of commitment to sound agricultural practices, detailed traceability and production processes,' said Nathan Mahalingam, CEO of Mission. "The European biodiesel market represents a multi billion dollar opportunity and we are honoured to be the first commercial scale provider of Jatropha to receive this important endorsement.'

www.missionnewenergy.com,
24 October 2011

EU biodiesel production declines in 2011

While in 2010 European Union (EU) biodiesel production registered a 5.5 per cent increase compared to the previous year, reaching a level of 9.57 million tonnes, the forecasts for 2011 show a reduction in the EU production compared to the same time last year. In addition, the 2010 increase remains low compared to growth rates registered in 2009 (17 per cent) and 2008 (35 per cent). The first quarter of 2011 shows a reduction of domestic European production. As of July 2011, European biodiesel production capacity was at 22 million tonnes. The number of existing biodiesel facilities stood at 254, slightly up from 2009 due to the start of a few new production units. This industrial base is the result of investments in biodiesel production planned before 2007 in order to meet ambitious objectives for biofuels consumption given by the EU authorities.

www.biofuels-news.com,
20 October 2011

Virgin to fuel planes using waste gases

Virgin Atlantic has announced the development of a 'world-first low carbon aviation fuel'. The ground breaking partnership with LanzaTech represents a breakthrough in aviation fuel technology that will see waste gases from industrial steel production being captured, fermented and chemically converted using Swedish Biofuels technology for use as a jet fuel. The revolutionary fuel production process recycles waste gases that would otherwise be burnt into the atmosphere as carbon dioxide to produce aviation fuel with just half the carbon footprint of the standard fossil fuel alternative. "This technology will enable airlines to dramatically reduce their carbon footprint by reusing gases that would otherwise have been emitted directly into the atmosphere. It promotes sustainable industrial growth, as the process enables manufacturing plants to recycle their waste carbon emissions," explains Dr Jennifer Holmgren, Chief Executive of LanzaTech.

Within two to three years, Virgin Atlantic plans flights with the new fuel on its routes from Shanghai and Delhi to London Heathrow as LanzaTech and partners develop facilities in China and India. The technology is currently being piloted in New Zealand, a larger demonstration facility will be commissioned in Shanghai this year, and the first commercial operation will be in place in China by 2014. Following successful implementation, a wider roll-out could include operations in the UK and the rest of the world. LanzaTech estimates that its process can apply to 65 per cent of the world's steel mills, allowing the fuel to be rolled out for worldwide commercial use. The energy company believes that this process can also apply to metals processing and chemical industries, growing its potential considerably further.

www.virgin-atlantic.com,
18 October 2011

Air France flies on biofuels

Air France has successfully completed a flight powered by biofuel. The Airbus A321 flew from Toulouse and Paris/ Orly, using 50/50 blend of biofuels and aviation fuel in both engines. This biofuel/jet fuel mix, combined with the use of 'optimised' air traffic management (ATM) procedures, such as continuous descent approach, helped to slash the flight's CO_2 emissions by 50 per cent. Airbus said the flight's carbon output was reduced by 54 g per passenger per km.

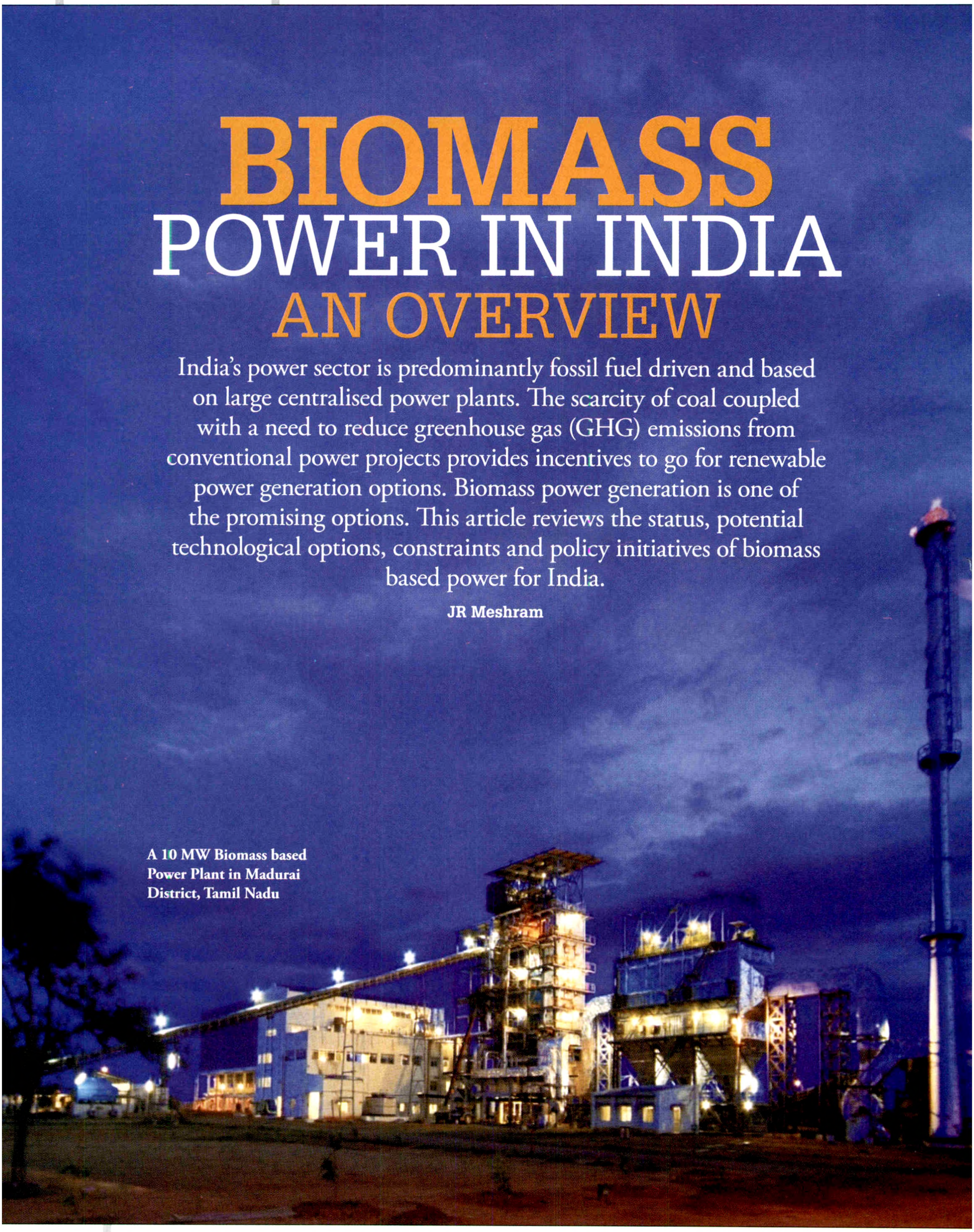
www.biofuels-news.com, 24 October 2011

BIOMASS POWER IN INDIA

AN OVERVIEW

India's power sector is predominantly fossil fuel driven and based on large centralised power plants. The scarcity of coal coupled with a need to reduce greenhouse gas (GHG) emissions from conventional power projects provides incentives to go for renewable power generation options. Biomass power generation is one of the promising options. This article reviews the status, potential technological options, constraints and policy initiatives of biomass based power for India.

JR Meshram



A 10 MW Biomass based Power Plant in Madurai District, Tamil Nadu

The term 'biomass' in the Indian context needs an explanation as in India it primarily means the residue of crops, crop processing and forests. By general convention, municipal and industrial waste, cow dung and human waste, etc. are taken as a separate category of biomass. The biomass materials produced in the country have traditionally been used in two ways - as animal feed and as domestic fuel. In recent years, use of some residues, typically rice husk, as boiler fuel in industries has multiplied manifold. Inspite of these uses, a considerable portion of the total biomass produced in the country is believed to be wasted. In addition, the efficiency of biomass used in domestic stoves is known to be low which, if improved, could result in availability of significant surplus quantities. The extensive use of liquefied petroleum gas (LPG) presently in rural areas also contributes to surplus quantities of biomass.

It is the power generation potential of biomass, however, which has been attracting greater attention in recent times. High cost of diesel, shortage and non-availability of coal for captive power generation, recurrent shortages of power for industrial use and the recent thrust on distributed generation, have added to the interest in this option. The Ministry of New and Renewable Energy (MNRE) recognised the potential role of biomass power in the Indian economy quite early and has been actively promoting the sector. Over the last two and a half decades, biomass power has become an industry, which attracts annual investments of over Rs 4,000 crores, generates more than 700 crore units of electricity and creates employment opportunities of more than 15 million man days in rural areas. Further outcomes of the carefully planned mix of policy and fiscal/financial incentives introduced by the Government have been capacity building in the country for absorption of biomass power technologies, their operation and maintenance, management of biomass collection, manufacturing of equipment and resolving of grid interfacing issues.

POTENTIAL OF BIOMASS POWER IN INDIA

The Ministry noted the need for an assessment of this huge resource and a comprehensive survey was sponsored, undertaken by the National Productivity Council (NPC) in 1985-86. The seminal work recorded the ratios of various crop residues and useful products through extensive field surveys and based on these went on to estimate the state wise and crop wise residue generation. It was realised that the amounts of recoverable residues are a function of geographic region, seed variety and even of the harvesting methods employed. Thus, for the purposes of gross quantum, an estimate was made on the basis of average value of crops to residue ratios. The ratios have been moderated from time to time as additional information comes in. The currently used values are given in Table 1, which also shows that around 500 million tons of residue was produced in the country during 2006-07. These values may be used for assessment of the potential, with the understanding that the actual amounts may differ by 15-20 per cent.

> **The Ministry of New and Renewable Energy recognised the potential role of biomass power in the Indian economy quite early and has been actively promoting the sector.**

Although the NPC survey made some projections, the figures lacked a rigorous basis. The Ministry took lead in this direction by sponsoring taluk/district level biomass studies from 1995 to 2004. The studies covered 500 taluks and about 100 districts in 23 states and estimated surplus biomass amounts through household surveys. Trends derived from the studies show that on a countrywide average, 15-20 per cent of the total crop residues can be made available for power generation without affecting present uses significantly. In the northern states of Punjab, Haryana and Uttar Pradesh (UP), surpluses are much higher due to multiple cropping and the per capita production of biomass is also higher.

In addition to present surpluses, estimation of the biomass, which can be made surplus by planned interventions, is also important. Around 220 million tons of biomass is used as fuel by households in traditional cooking devices, which have an end use efficiency of not more than 10 per cent. This could be improved to 20 per cent by introduction of improved models of cooking stoves. Thus, 100 to 110 million tons of biomass can be made additionally available. This, added to 15-20 per cent normal surplus, would become 150-160 million tons per year. This would be sufficient for sustaining 16000 to 18000 MW of power generation capacity with a plant load factor of 60-80 per cent.

India is the world's second biggest producer of sugarcane. Indian sugarcane production during 2010-11 is estimated to be 340 million tons, which in turn would have generated around 50 million tons of dry bagasse. India's 527 working sugar mills crush around 240 million tons of cane per year and generate 80 million tons of wet bagasse (50 per cent moisture), of which they consume around 70 million tons for meeting captive requirements of power and steam. It was pointed out by a Task Force appointed by the Ministry in 1993, that if all the sugar mills were to adopt technically and economically optimum levels of cogeneration for extracting power from the bagasse produced by them, around an additional 3500 MW could be generated. Based on present capacity of sugar mills, higher pressure/temperature configurations (87 kg per sq cm and 510°C and 110 kg per sq cm and 540°C), and reduction in process steam consumption on cane the potential has been revalidated to 5000 MW of surplus power.

Sugarcane cultivation also results in production of trash in the fields comprising mainly of dry leaves. It typically constitutes around 7 per cent of clean cane, and is disposed

Fig 1. Biomass Power Generation Technology Options

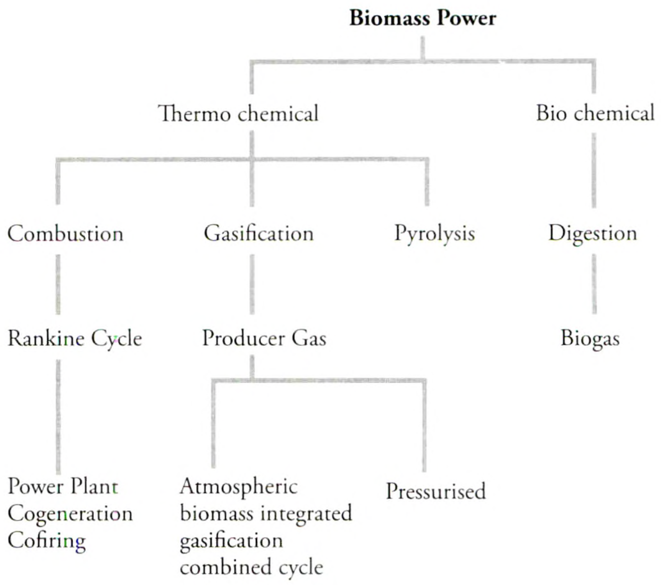


Table 1. Estimates of Biomass Produced in India (Based on Agricultural Production for 2006-07)

Crop	Production (million tons of main crop)	Types of residues	Production of main crop to residue ratio	Quantity of residues (million tons per year)	Typical uses of residues
Rice	90	Straw	1.3	117	As cattle feed in South and East India. Generally burnt in the fields in North India.
		Husk	0.3	27	As a fuel by small industry.
Wheat	80	Straw	1.5	120	Mainly as cattle feed.
Coarse cereals	30	Straw and husk	1.8	54	As cattle feed and fuel.
Sugarcane	320	Bagasse	0.3	96	Mainly as a captive fuel by sugar plants, partly as raw material for paper making.
		Tops	0.05	16	As cattle feed.
		Trash	0.07	20	Mostly burnt in the fields.
Coconut	14 billion nuts	Shell	0.13 kg per nut	0.2	Partly as domestic fuel.
		Fibre	0.2 kg per nut	2.8	Partly for making mattresses, carpets, etc.
		Pith	0.2 kg per nut	2.8	No productive use. Disposal is a problem.
Cotton	3.5	Stalk	3.0	10.5	Partly as domestic fuel.
		Gin Waste	0.1	0.35	As fuel for brick making and by small industry.
Oilseeds	20	Straw and husk	1.1	22	Domestic Fuel.
Pulses	14	Straw	1.3	18	Partly as a domestic fuel.
Jute/Mesta	2.0	Stalk	2.0	4	Partly as fuel for processing tobacco leaves/ domestic fuel.
Total				**510**	

Note: Figures are rounded off to the nearest meaningful numbers.

Source: Agricultural Production Data, Ministry of Agriculture, http://agricoop.nic.in. The residue ratios and use patterns from the reports of taluk level studies sponsored by MNRE (1998-2004) off by burning in fields, or, is mulched in the soil. About 20 million tons of trash is produced every year. This could also be used as supplementary fuel for generation of power for extending off-season power generation.

Knowledge of a reasonable estimate of biomass availability in the vicinity of a proposed power project location is a prerequisite for planning biomass power projects. The Ministry has taken an innovative step to make such data available by sponsoring a project to the Indian Institute of Science (IISc) under which a geographic information system (GIS) based 'Biomass Atlas' has been developed. The atlas is available online (http://lab.cgpl.iisc.ernet.in/Atlas/) and can be used by prospective project promoters to make an initial assessment of availability of biomass.

CONVERSION OF BIOMASS TO ELECTRICITY

Biomass based power generation can have higher capacity factors than solar or wind. Biomass can be stored and can be used to feed a dispatchable power plant. The different options for power generation from biomass are listed in Fig 1. The main conversion options are thermo chemical or bio chemical. The thermo chemical processes involve combustion, gasification or pyrolysis.

Combustion

The most commonly used route is combustion. The cycle used is the conventional Rankine cycle with biomass being burnt in the boiler to generate steam, which is expanded through turbines to generate work output. Biomass power plants account for about 1000 MW of existing capacity. The power plant ratings vary from 3 to 12 MW. The net power cycle efficiencies that can be achieved are about 23-25 per cent. Most of the boilers used are of the spreader stoker (moving grate) type. The boiler efficiency is expected to be around 70 per cent. The advantage of the combustion route is that the technology used is similar to that of a thermal plant based on coal, except for the boiler.

The gas turbine route is potentially more efficient, but India has no experiences with biomass integrated gas turbine combined cycle (BIGCC) technologies. International experience in BIGCC is limited and the technology is still in the demonstration phase.

Cogeneration

Cogeneration is a facility which simultaneously produces two or more forms of useful energy such as electric power and steam. The Biomass Cogeneration Programme is currently divided into two components – bagasse and non-bagasse based. While bagasse cogeneration is essentially sugar mill oriented, non-bagasse biomass cogeneration can be used in biomass industry. The Ministry has two separate programmes for these.

> **The Biomass Cogeneration Programme is currently divided into two components – bagasse and non-bagasse based and the Ministry has two separate programmes for these.**

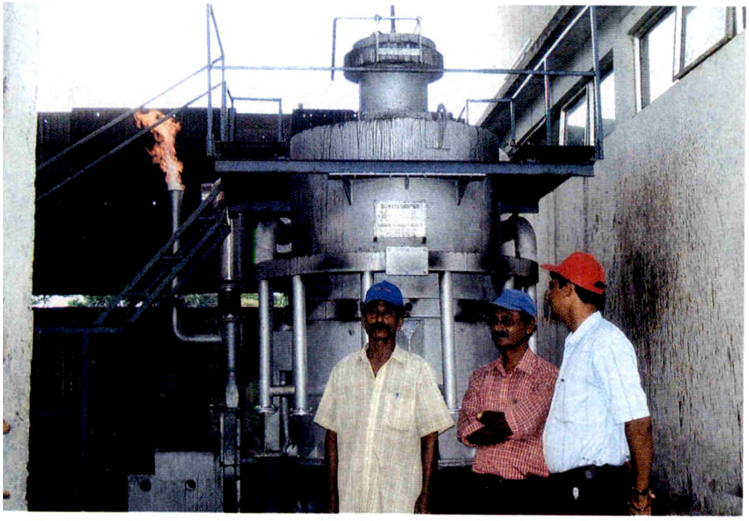
10 MW Biomass Power Project at Gadchiroli District, Maharashtra

Bagasse Cogeneration

In India, sugar mills have always cogenerated steam and electricity using bagasse produced during crushing. Before the 1970s, steam generation pressure/temperature and boiler/turbine efficiencies were low while steam requirements for the process were high and hence the mills were neither self sufficient in their steam requirements, nor in electricity. Over the years, more efficient boilers/turbines and higher pressure steam generation were adopted and by 1990s, the mills started to not only become self sufficient in steam and electricity, they even had some surplus bagasse.

Advancements in the steam generation technology and the increased confidence of sugar industry in them have now emboldened some mills to adopt even higher pressures of steam generation. Thus, while a typical 2500 ton crushed per day (TCD) sugar mill cogenerating only for its own needs would generate 3.5-4.5 MW of electricity in optimum

> **The Indian efforts for promotion of biomass power started with a 10 MW project using rice straw in Punjab. The project initiated in 1988 was completed in 1992.**



600 kW Biomass Gasifier at a bakery in Tezpur, Assam

cogeneration mode, this could go to 13.5 MW of which 9 MW would be sold. In a state-of-art case, the surplus could be as high as 10-12 MW.

Biomass Gasification

Instead of combustion, it is possible to convert the biomass into producer gas by gasification (partial combustion). Thermo chemical gasification involves burning the biomass with insufficient air so that complete combustion does not occur but a gaseous product is obtained. The producer gas is a mixture of carbon monoxide and hydrogen. Gasifiers are classified as updraft or downdraft depending on the direction of flow of the biomass and producer gas. India has significant experience in atmospheric gasifiers.

Biomass Cofiring

Cofiring of biomass along with coal in thermal power plants is another option that has been adopted in some European countries and the United States (US). This has been developed by utilities as a response to portfolio standards and developing markets for green power. Cofiring results in reduced emissions of GHG (since biomass is almost carbon neutral) and local oxides of nitrogen and sulphur (NOx and SOx). Although not tried in Indian coal plants yet, biomass cofiring tests have been carried out in the US in coal power plants of rating between 32-700 MW. Cofiring can be done by blending biomass with coal or firing biomass separately. This has been found to be the most cost effective way to increase the biomass share in the power generation mix and reduce carbon dioxide emissions. It has been suggested that Indian takes up few pilot cofiring projects.

CURRENT STATUS OF BIOMASS TECHNOLOGY

Biomass Combustion

Beyond a certain power generation capacity, Rankine cycle based power projects may prove to be more economical as compared to gasifier based power projects. For projects of more than 3-5 MW, the overall efficiencies (biomass to electricity) are likely to be higher with the Rankine cycle configuration and thus the higher initial costs would be compensated. Greater fuel flexibility is also possible with Rankine Cycle based systems.

The advantages will be important till the time Biomass Integrated Gasifier-cum-Gas Turbine (BIG-GT) combined cycle systems, can propel the overall efficiencies of biomass conversion to over 50 per cent, is perfected.

The Indian efforts for promotion of biomass power started with a 10 MW project using rice straw in the agriculturally rich state of Punjab. The project initiated in 1988 was completed and commissioned in early 1992. It uses a custom built, overfeed fluidised bed boiler designed and fabricated by Bharat Heavy Electrical Limited (BHEL).

The second concurrent project in private sector was commissioned in 1992 in Haryana. The 4 MW project was designed primarily as a captive power plant for a medium density particle board company and was synchronised with the grid for sale of excess power. The main fuel used was cotton stalk, in a spreader stoker, travelling grate boiler along with other biomass materials including rice husk and wood. The project has been running successfully for the last 15 years.

HCL Agro Biomass Power Project

This was the first biomass power demonstration project sanctioned by the Ministry in 1994. A capital subsidy of Rs 70 lakhs per MW was sanctioned for the 6 MW demonstration project. Loans were sanctioned by Indian Renewable Energy Development Agency (IREDA) and Industrial Development Bank of India (IDBI). The equipment was imported from China. *Prosopis Juliflora*, available in abundance near Vijayawada in Andhra Pradesh was used as the fuel. The project was commissioned in 1997. Although the technical configuration of the project was not as efficient as the latter projects, it proved to be a trend setter and fired up the imagination of promoters who set up large number of biomass power projects in Andhra Pradesh in subsequent years.

Indo Lahri Biomass Power Project

This 6 MW project was the second demonstration project sanctioned by the Ministry under its Biomass Power Programme. The project was designed for rice husk and all the equipment was obtained from indigenous sources. The promoters tried to build-in high efficiency of operation at every stage and hence used a fluidised bed boiler with an efficient steam turbine. The project was commissioned in 1996. The biomass project paved the way for more such projects in Chhattisgarh.

A capacity of around 1100 MW has been commissioned through 141 projects in the states of Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Karnataka, Madhya Pradesh (MP), Maharashtra, Punjab, Rajasthan, Tamil Nadu (TN), UP and West Bengal (WB), while over 150 MW is under implementation through 12 projects in the country.

Bagasse Cogeneration in Sugar Mills

Indian efforts for promotion of bagasse cogeneration started with 2 pilot projects taken up in co-operative sugar mills in Tamil Nadu in 1988-89 for generation of surplus power to feed the grid. The projects were financially supported by the Ministry through a one time capital subsidy. The mills used 45 bar steam boilers with 3 x 2.5 MW back pressure turbines. It was expected that up to 4.5 MW of electricity would be fed into the grid by each of the mills. The projects helped in generating confidence in grid synchronisation, regular payments by the State Electricity Board (SEB) for electricity fed into the grid and uninterrupted operation of the mills even with grid synchronisation for export of power. The information about the projects was placed in the public domain and was made available to those interested in learning from the experience of these mills. The successful operation of these projects went a long way in inspiring confidence among the other mills.

The Programme on bagasse based cogeneration initiated in 1993 by the Ministry lays emphasis on high efficiency use of bagasse and intends to promote optimum cogeneration by demonstration of state-of-the-art technologies by providing financial incentives to other projects, and by providing support for information dissemination, research and development (R&D), and training activities. The process of 'optimum cogeneration' could lead to augmentation of grid power as well as benefit the sugar mills through higher value addition to bagasse.

> **The Programme on bagasse based cogeneration initiated in 1993 by the Ministry lays thrust on high efficiency use of bagasse and intends to promote optimum cogeneration by demonstration.**

30 MW Bagasse Cogeneration Project at a sugar mill in Maharashtra

A limited number of 'demonstration' projects offered capital subsidies to partly compensate for the risks, which these pioneering mills would be taking by using untried technologies. Minimum surplus power generation of 5 MW and use of 60 bar/450°C steam pressure/temperature conditions, have been stipulated. The scheme was designed in a manner so as to provide higher encouragement to co-operative/public sector sugar mills, which constitute over 60 per cent of the mills in the country.

Though possibilities of additional power generation through cogeneration in sugar industry has been known for long, their exploitation started in a significant manner only after 1994, with the announcement of the programme on bagasse based cogeneration by the Government. When the Ministry initiated its programme on bagasse cogeneration the 45 bar/440°C steam pressures were just being introduced. This was then increased to 65 bar/485°C, after the initial demonstration projects were set up with capital subsidy from the Ministry. By 2004, the steam pressures/temperatures had increased to 85 bar/510°C and in 2007 mills were adopting 110 bar/540°C steam conditions. On the basis of cane, these figures would translate to surplus electricity generation of 80-130 kWh per ton. Optimum bagasse cogeneration benefits

> **A network of research institutions was built up over the years for developmental work on various facets of biomass gasification.**

900 kW thermal gasifier system installed at a welding industry in Hosur, Tamil Nadu.

not only the sugar mills but also the sugarcane farmers as the value of their cane is enhanced. The programme demonstrated the viability of the technology to the sugar industry, the State Governments and the SEBs. A capacity of around 1854 MW of surplus power generation has so far been commissioned in 170 sugar mills in the states of Andhra Pradesh, Bihar, Haryana, Karnataka, Maharashtra, Punjab, Tamil Nadu, Uttar Pradesh and Uttarakhand. More than 200 MW of projects in about 20 private sector sugar mills are under construction.

Out of 527 sugar mills in India, 60-65 per cent are in the co-operative/public sector. Due to barriers such as inability to raise equity and debt, delays in decision making and high risk/high investment proposals, sugar mills in this sector are unable to implement high efficiency cogeneration power plants for optimum power export. The Ministry has made focused efforts in this very difficult sector particularly over the last decade. This includes provision of higher quantum of capital grants for the co-operative sector, capacity building initiatives, promotion of build-own-operate-transfer (BOOT) model and continuous follow up with co-operative/public sector sugar mills and stakeholders. These efforts have provided excellent results during the last 3 years. Cogeneration projects are under implementation in over 25 co-operative sugar mills in Maharashtra (300 MW exportable surplus). BOOT model projects in 12 co-operative/public sector sugars mills in Tamil Nadu of aggregate capacity 180 MW and BOOT model cogeneration projects in 2 co-operative sugar mills of Maharashtra of total capacity 80 MW are under implementation. The Ministry would like to extend this effort in the co-operative/public sector sugar mills in the states of Karnataka, Andhra Pradesh, Gujarat and Uttar Pradesh, during the next two to three years. Efforts will be made for full utilisation of estimated potential in sugar mills by end of 13th Plan. Efforts will be made for tapping potential during the operating period of cogeneration power plants from 160-180 days to 280-290 days in a year by utilising other available biomass and cane trash.

Gasification Programme

It is one of the first biomass power programmes to have been initiated by the Ministry from 1985 onwards. The Programme intends to promote development, demonstration and commercialisation of biomass gasifier based systems for water pumping, mechanical power and thermal applications, and generation of electrical energy for captive industrial applications or for rural electrification.

A network of research institutions was built up over the years for developmental work on various facets of biomass gasification. Some of the activities are development of application packages; testing and evaluation; characterisation of biomass materials; etc. The biomass gasifier-dual fuel engine power packs can use a variety of woody biomass materials for power generation in MW capacity (electric) with around 80 per cent diesel displacement. Rice husk, coconut shells, etc. are some other materials reported to have been successfully tried in gasifiers. The present generation of biomass gasifier uses 100 per cent producer gas for power generation. Around 2000 systems with capacities ranging from 40 kW to 200 kW are used in rice mills and other industries while about 60 rice husk based distributed power generation systems of 32 kW capacity have been successfully demonstrated based on a revenue model in Bihar.

The gasifiers are almost exclusively of down draft, atmospheric pressure design and are primarily designed for firing woody biomass. The cooling/cleaning systems have also been developed considerably and at present gas qualities suitable for operation of 100 per cent producer gas engines are being guaranteed. Presently, 100 per cent producer gas (PG) engines are available in sub MW capacities in the country. Around 2000 gasification systems aggregating 130 MW equivalent capacity have so far been installed in the rice mills and other industries for captive power and thermal applications.

NEW INITIATIVES

BOOT Model Cogeneration Projects in Co-operative Sugar Mills

There is a provision for central financial assistance (CFA) for bagasse cogeneration projects taken up through BOOT model in co-operative sector sugar mills set up by special purpose vehicle (SPV) or an independent power producer (IPP). This model has advantages in terms of non-requirement of equity and loans by co-operative sugar mills with zero liability to repay and a limited risk. The investment in a cogeneration power plant with concurrent modernisation is done by a BOOT developer. There is additional revenue to the farmer shareholder by way of royalty per ton of sugarcane crushed. The cogeneration plant and assets after BOOT period are handed over to the co-operative sugar mills. The Ministry has supported the BOOT model projects in Maharashtra and Tamil Nadu. This initiative has provided excellent results.

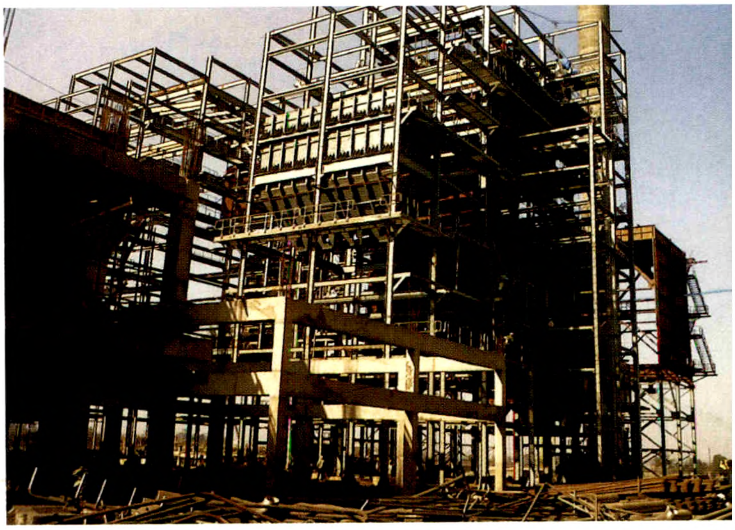
Boiler Modification in Co-operative Sugar Mills

A number of recently installed co-operative sugar mills have already employed 40 kg/cm^2 project configuration. For enabling them to undertake cogeneration power projects with minimum investment through modification of existing boiler and matching turbine, the Ministry has modified the scheme for providing CFA for boiler upgradation of cogeneration project in such sugar mills.

Renewable Energy Certificate

Renewable Energy Certificates (RECs) by which energy generated and fed to the grid will entitle the generators to trade the RECs issued to them were notified in January 2010. REC seeks to address the mismatch between availability of renewable sources and the requirement of the obligated entities to meet their renewable purchase obligation (RPO). It allows certificate holders to sell renewable electricity at non-preferential tariff and sell the environmental attribute of renewable electricity through energy exchange to desirous entities.

> **REC seeks to address the mismatch between availability of renewable sources and the requirement of the obligated entities to meet their renewable purchase obligation (RPO).**



44 MW Bagasse Cogeneration project under implementation at Kolhapur District, Maharashtra on 'BOOT' Model.

CURRENT FISCAL INCENTIVES AND STATE POLICIES

A package of fiscal concessions such as accelerated depreciation, concessional custom duty, excise duty exemption, tax exemption, income tax exemption on projects for power generation for 10 years and electricity duty exemption etc. are available to biomass power projects. The tariff announced by the regulatory commissions of different states for biomass power/cogeneration are given in Table 2.

CURRENT STATUS OF BIOMASS POWER INDUSTRY

Biomass power purchase agreements (PPAs) are signed for a long duration of 25 years. The escalation clauses do not factor-in ground situation. Biomass prices are subject to high volatility and therefore it has been observed that over a period biomass power tariff has become an unviable proposition for many developers and it has led to a situation where many developers are seriously considering shutting down the biomass power plants. Over the last one year, the biomass industry has witnessed rising costs of inputs beyond the levels considered in the tariff fixed by the regulatory authorities leading to unviable operations. Delays in payments by the state utility also add to the industry's woes. Although the aggregate installed capacity of the independent biomass power generators is about 1000 MW, the current capacity utilisation has been only 50 per cent. Most of the biomass power plants in the different States

Table 2. Tariff Announced by Regulatory Commissions of Different States for Biomass Power and Cogeneration Projects. (As on 1 November 2011)

State	Tariff fixed by the Regulatory Commission				Renewable Purchase Obligation (RPO) (per cent)
Andhra Pradesh	BM Cogen	@ Rs 4.28 per kWh @ Rs 3.48 per kWh	2010-11		Minimum 3.75
Bihar	BM Existing Cogen New Cogen	@ Rs 4.17 per unit @ Rs 4.25 per unit @ Rs 4.46 per unit	2010-11 2010-11 2010-11		1.5
Chhattisgarh	BM for old projects BM for new projects	@ Rs 3.95 per unit @ Rs 4.15 per unit	2011-12		5
Gujarat	BM Cogen	@ Rs 4.40 per unit @ Rs 4.55 per unit	for first 10 yrs	with accelerated depreciation	10
Haryana	BM Cogen	@ Rs 4.00 per unit @ Rs 3.74 per unit		with 3 per cent escalation (base year 2007-08)	1
Jharkhand	Air cooled Water cooled	@ Rs 5.53 per unit @ Rs 5.31 per unit	2011-12 2011-12	with 3 percent escalation variable cost	3
Karnataka	BM BM Cogen Cogen	@ Rs 3.66 per unit @ Rs 4.13 per unit @ Rs 3.59 per unit @ Rs 4.14 per unit	(PPA signing date) (10th year) (PPA signing date) (10th year)		Minimum 10
Kerala	BM	@ Rs 2.80 per unit	2000-01	escalated at 5 per cent for five years	3
Maharashtra	BM Cogen	@ Rs 4.98 per unit @ Rs 4.79 per unit	2010-11 2010-11		6
Orissa		@ Rs 4.87 per unit	2011-12	with 3 per cent escalation variable cost	5
Punjab	BM Cogen	@ Rs 5.12 per unit @ Rs 4.80 per unit	2011-12 2011-12	escalated at 5 per cent	Minimum 3
Rajasthan	BM Cogen	@ Rs 4.72 per unit @ Rs 5.17 per unit	2010-11 2010-11	0.35	1.75
Tamil Nadu	BM Cogen	@ Rs 4.50-4.74 per unit @ Rs 4.37-4.49 per unit	2010-11 2010-11	escalation at 2 per cent	Minimum 13
Uttarakhand	BM Cogen (new projects)	@ Rs 3.06 per unit @ Rs 3.12 per unit	2010-11 2010-11		9
Uttar Pradesh	for existing for new	@ Rs 4.29 per unit @ Rs 4.38 per unit		escalated at 4 paise per year (base year 2006)	4
West Bengal	BM	@ Rs 4.36 per unit	fixed for 10 years		4

Note: For latest updates kindly contact the concerned Regulatory Commission face imminent shut down on grounds of viability leading to loss of employment of labour, both direct and indirect, apart from impacting the revenue streams of the farmers and intermediaries in the rural sector. The biomass industry association has already made suitable representations to concerned Electricity Regulatory Commissions (ERCs) along with the detailed cost justification/workings. The tariff revisions are still pending and the delay is causing difficulties to the industry.

NEW POLICY INITIATIVES

The major policy initiatives include support to biomass power producers on revision of current tariff, introduction of variable tariff component through weighted average of the cost of biomass resource used in the state, removal of control period and formulation of exclusive state biomass policy to promote the viability and growth of the sector. It is noteworthy that in the final analysis the beneficiaries of higher cost of inputs in biomass sector are only those in the state rural economy and not the private investors in these projects. In the near term, the policy can envisage shift towards lower capacity biomass power plant (say unit size 2-4 MW) as it will be more sustainable in terms of fuel procurement and transportation. In many countries, developments have taken place for smaller capacity 'unit design' biomass plants for utilising biomass with higher levels of moisture content etc. All these will mean higher initial cost per MW, but sustained power generation for about 300 days in a year will make the project profitable. Further, establishment of adequate supply base of inputs for exclusive use of biomass power producers with the active involvement of the district collectors (similar to allocation/procurement of sugar cane under the overall supervision of the sugar commissioners nominated by the state) will be beneficial. In the medium term such a policy could pave the way for promotion of dedicated energy plantations through appropriate waste land development programmes in each taluk/district based on a suitable public private partnership (PPP) model or contract farming, for the long term sustainability of the supply of biomass feed stock to the biomass power industry.

FUTURE POSSIBILITIES AND CONCLUSIONS

It is apparent that biomass is an important energy resource for enhancing power generation capacity in India. Apart from financial benefits to the promoters of these projects, the society benefits due to intangible advantages such as employment generation in rural areas, environmental benefits, distributed power generation, etc. The potential estimated for power generation from the present surplus materials could be further increased with development of technology and consequent increase in biomass conversion efficiencies. For example, the present efficiencies of conversion of biomass to electricity through steam turbine or gasification route are in the range of 18-22 per cent. With success in commercialisation of biomass integrated gasification cum combined cycle technology, the conversion efficiencies could be doubled and hence from the same biomass, power generation potential could also be doubled. Further, intensive cultivation of waste and marginal lands for energy crops, with use of advanced plantation techniques could enable the country to increase its biomass power potential even more. It is in light of these possibilities that MNRE has been engaged in promotion of biomass based power generation. Future strategy may include the following points.

- Continuation of policy support from the Ministry for the XII Five Year Plan, between 2012-2017 period, with innovative measures and enabling features.
- Encouragement to sugar mills for off-season power generation by utilising other available biomass and cane trash.
- Encouragement to mini biomass power plants of smaller capacity, say 2-4 MW.
- Guidance on tariff fixation for biomass from MNRE to Central Electricity Regulatory Commission/ State Electricity Regulatory Commissions (CERC/SERC's) for introducing variable tariff component on the cost of biomass resources used in a state including for existing PPAs by the states/power transmission companies.
- Development of suitable technologies for straw and stalks, which are a major resource in the states of Punjab, Haryana and Bihar.
- Development of fuel value chain business model through fuel management companies and biomass depot system for harvesting transportation, storage and supply of fuel to a power plant.
- Encouragement to biomass power linked with dedicated plantation on wasteland and non forest degraded land for power generation.
- Initiation of a Biomass Mission with a view to promote various programmes for development of technology and market for different biomass based energy programmes.
- Introduction of Generation Based Incentive (GBI) Scheme for incentivising efficiency in biomass power projects. ✪

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Solar Pumps for Irrigation & Drinking Water
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31st India International Trade Fair

14-27 November 2011

This year's IITF was expected to attract 1.5 million visitors. Ministry of New and Renewable Energy (MNRE) also participated in the 14 day event at Pragati Maidan, New Delhi with overwhelming results.

Inaugurating the 31st edition of the India International Trade Fair (IITF) the Hon'ble Union Minister of Finance Shri Pranab Mukherjee said that despite setbacks, emerging economies will continue to grow - a fact that should be taken into consideration while deliberating about decision making architecture of global finances. He added that India's manufacturing sector has come of age with rapid strides in hightech products. A sign of a maturing economy he added, was the changing composition of the export basket to engineering related products. The Finance Minister expressed concerns about adoption of protectionist measures in the wake of the global crisis. Speaking on the occasion guest of honour, Shri Anand Sharma, Union Minister for Commerce, Industry and Textiles said that IITF is an example of the vision of India's first Prime Minister Shri Jawaharlal Nehru who adopted a policy of keeping India and its institutions at the cutting edge of development.

Renewable Energy In India

The world today is undergoing a transformational change and adjustment because of global warming and an increase in crude oil prices. It is recognised worldwide that fossil fuels are depleting fast and that their excessive use needs to be curbed. In this context, the role of efficiency and renewable energy (RE) in India is vital. The country has been making continuous progress in conventional as well as renewable power generation. From the year 2002 onwards, renewable grid capacity in the country has increased by about 5 times, which is about 10.90 per cent of the total grid installed capacity in the country, thereby contributing about 4.13 per cent to the electricity generation mix.

MNRE adopts a three fold strategy for the country:

- providing budgetary support for research, development and demonstration of technologies
- facilitating institutional finance through various financial institutions
- promoting private investment through fiscal incentives, tax holidays, depreciation allowance and remunerative returns for power fed into the grid.

MNRE is the nodal Ministry of the Government of India for all matters relating to renewable energy. India is the only country in the world to have such an independent Union Ministry as well as Renewable Energy Nodal Agencies in each State/Union Territory, for the development and promotion for RE.

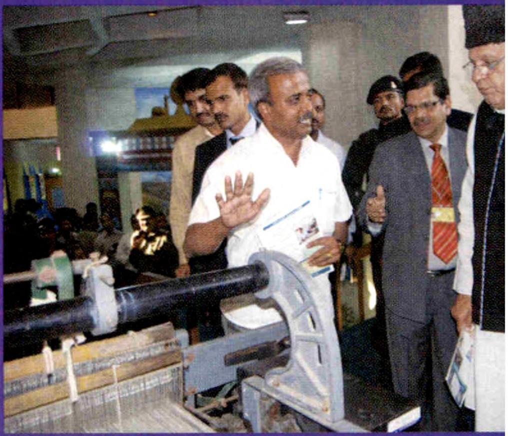
RE at the IITF

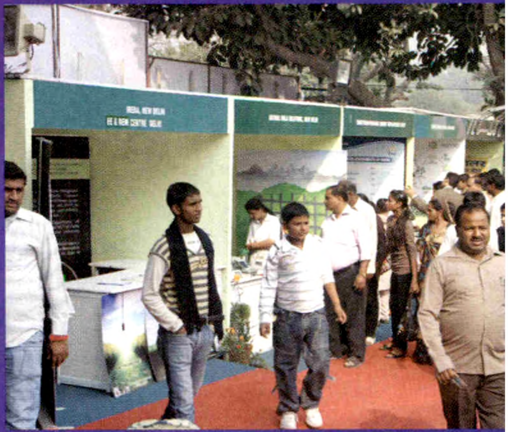
MNRE increased its outreach by putting in place high tech exhibits at Hall no. 20 of Pragati Maidan at the IITF. The ministry effectively encouraged development and promotion of all RE sources. 18 firms participated in the Fair under the MNRE umbrella including, Arunachal Pradesh Energy Development Agency (APEDA); EE & REMC Government of NCT of Delhi, Non-Conventional Development Agency (NEDA), Uttar Pradesh; Rajasthan Renewable Energy Corporation Limited (RRECL); Chhattisgarh Renewable Energy Development Agency (CREDA); Mahatma Gandhi Institute for Rural Industrialization (MGIRI); Bihar Renewable Energy Development Agency (BREDA); Bhambri Enterprise, New Delhi; Medors Renewable Energy, New Delhi; Rishipooja Energy & Engineering Company, Gorakhpur; Natural Oorja Solutions, New Delhi; Solanand Solar Systems, Ambala; Biotech, Thiruvanathpuram; Electrotherm India Limited, Ahmedabad; BK Consimpex Private Limited, Noida; Boom Systems Private Limited, Faridabad; Kalisons Televent Private Limited, New Delhi; and CEL, Sahibabad.

These firms/companies displayed innovative products related to solar, wind and tidal energy for the public. The dominant range of products in which people took a keen interest included solar water heaters and solar lanterns. The displayed products elicited a keen response for their competitive prices and the low cost of installation. The visitors were also informed about 'duplicate' solar panels. Almost all the products were being provided on government subsidy especially for the people living in remote areas.

Mr JP Singh of BREDA, Patna said that they provide solar panels of 75 wp (wattage) which have a warranty of 10-25 years and that the Government subsidises their products. A spokesperson from APEDA introduced the visitors to a fascinating 4 seater car costing only Rs 2,75,000 that can be easily charged by solar or electrical energy. Once charged it runs for up to 80 km.

It was encouraging to see the curiosity of the young and old visitors who were eagerly asking questions about RE products, which were on display at the different stalls. The people were happy to know about the provision of Government subsidies on various RE products and praised the Ministry for its efforts. Overall, the IITF proved to be an ideal and successful platform for promotion and encouragement of RE with nearly 22-24,000 footfalls at the MNRE pavilion everyday. ❂





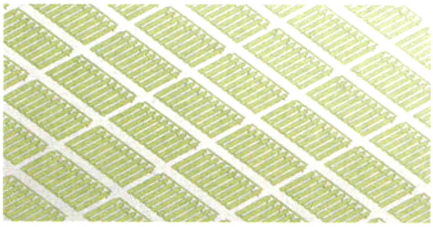
DIRECT LIQUID FUEL FROM SUN

A Massachusetts, USA based company Joule is advancing a technology platform for Liquid Fuel from the Sun™, expected to eclipse the scale, productivity and cost efficiency of any known alternative to fossil fuel today. Joule announced its recognition as the 2011 Wall Street Journal Technology Innovation Award winner in the category of Energy, chosen for its transformational approach to highly efficient renewable fuel production. "We are honoured to be the Wall Street Journal's choice for the most innovative energy company, and to be recognised even beyond our industry as one of the world's top innovators overall," said Bill Sims, President and CEO of Joule.

"We started with a big idea – the direct conversion of sunlight to fuel without raw material feedstocks – and four years later we've proven the process, optimised the technology, built a strong patent portfolio and laid the groundwork for commercial production to begin in 2013. We will bring much needed scalability and infrastructure readiness to the renewable fuels space, with a platform that can yield multiple products, including valuable, fungible diesel fuel vs. a blendstock like biodiesel. We appreciate this recognition of our company's efforts to successfully innovate outside of today's common 'biofuel' definition," said Sims.

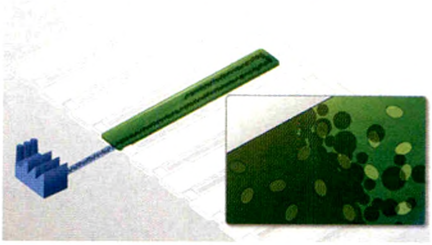
Unlike the costly, multi-step production of biofuels from biomass, Joule's Helioculture™ platform directly and continuously converts solar energy to infrastructure compatible fuels and chemicals, including fungible diesel and ethanol. The platform combines breakthroughs in genome engineering, process engineering and solar capture and conversion to achieve productivities that will be up to 100X greater than biomass dependent processes, while avoiding depletion of agricultural land or fresh water. Using sunlight and waste CO_2 from industrial emitters or pipelines, with a modular SolarConverter® system that allows ease of scale, Joule targets commercial production of up to 15,000 gallons of diesel and 25,000 gallons of ethanol per acre annually, at stable costs as low as USD 20 per barrel and USD 0.60 per gallon respectively, including subsidies. Joule has been conducting pilot operations for over a year and will begin construction of its first demonstration scale plant at the end of the year Source: www.jouleunlimited.com, 18 October 2011.

The Helioculture™ Platform

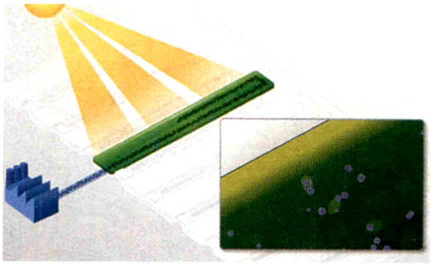


1. A typical *SolarConverter®* array will encompass 1,000 acres, and enable direct, continuous production of infrastructure-ready fuels or chemicals.

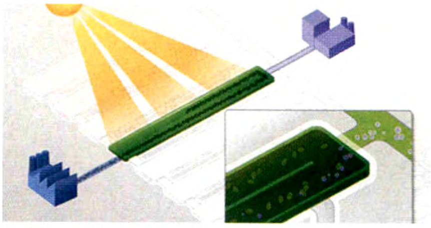
2. Each module of the *Solar Converter* system contains Joule's engineered microorganisms, non-potable water and micronutrients.



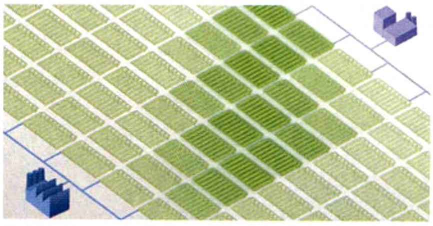
3. Waste CO_2 is pumped in from an industrial emitter or pipeline.



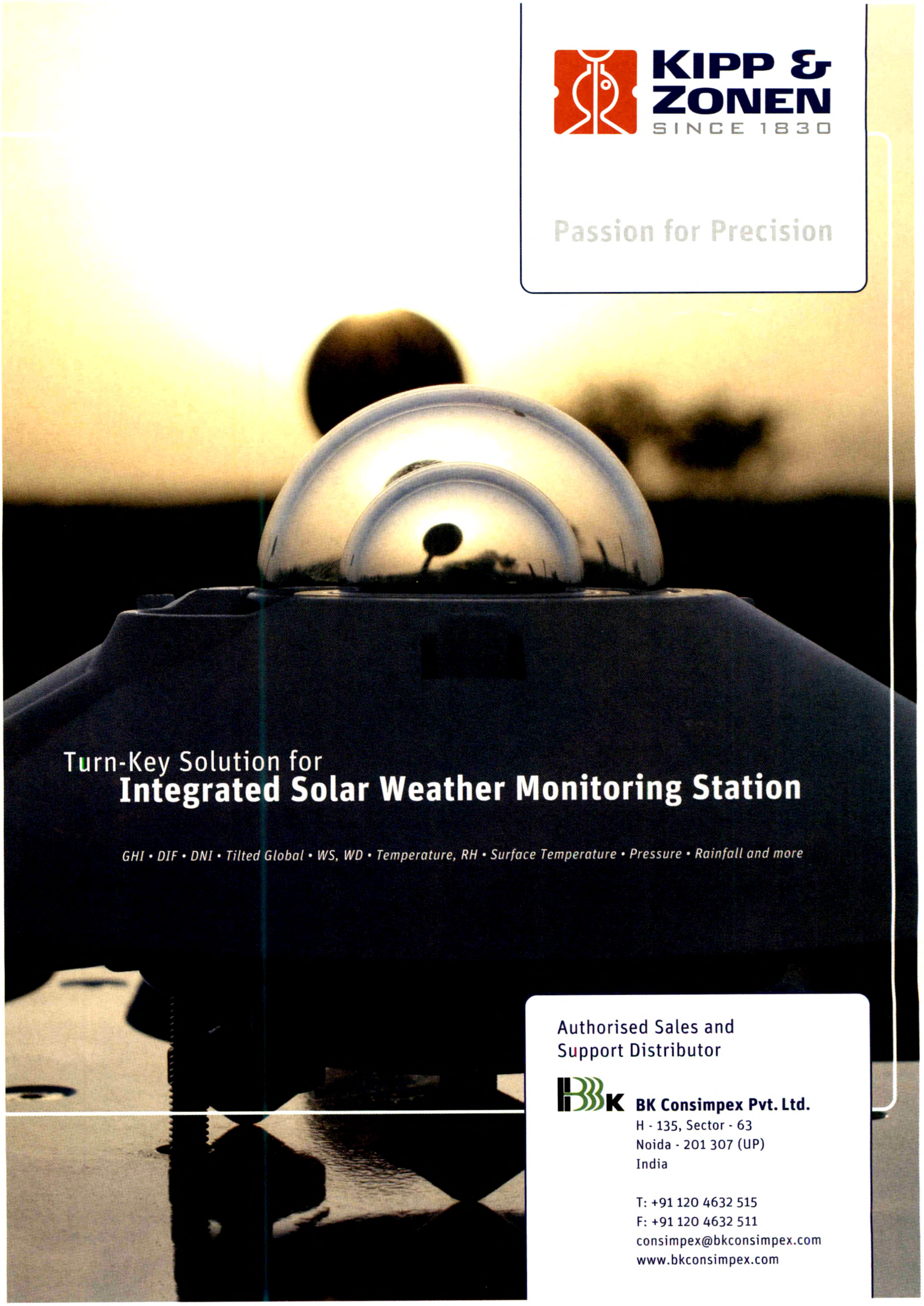
4. The CO_2 keeps the microorganisms in motion, maximising their exposure to sunlight to drive photosynthesis. Charged from the sunlight, the microorganisms consume the CO_2 and continuously produce and secrete the fuel or chemical molecules into the medium.



5. The medium circulates through a separator that extracts the end product, which is sent to a central plant for final separation and storage.



6. The process occurs continuously for up to 8 weeks before the module is flushed and reinoculated on a staggered basis.



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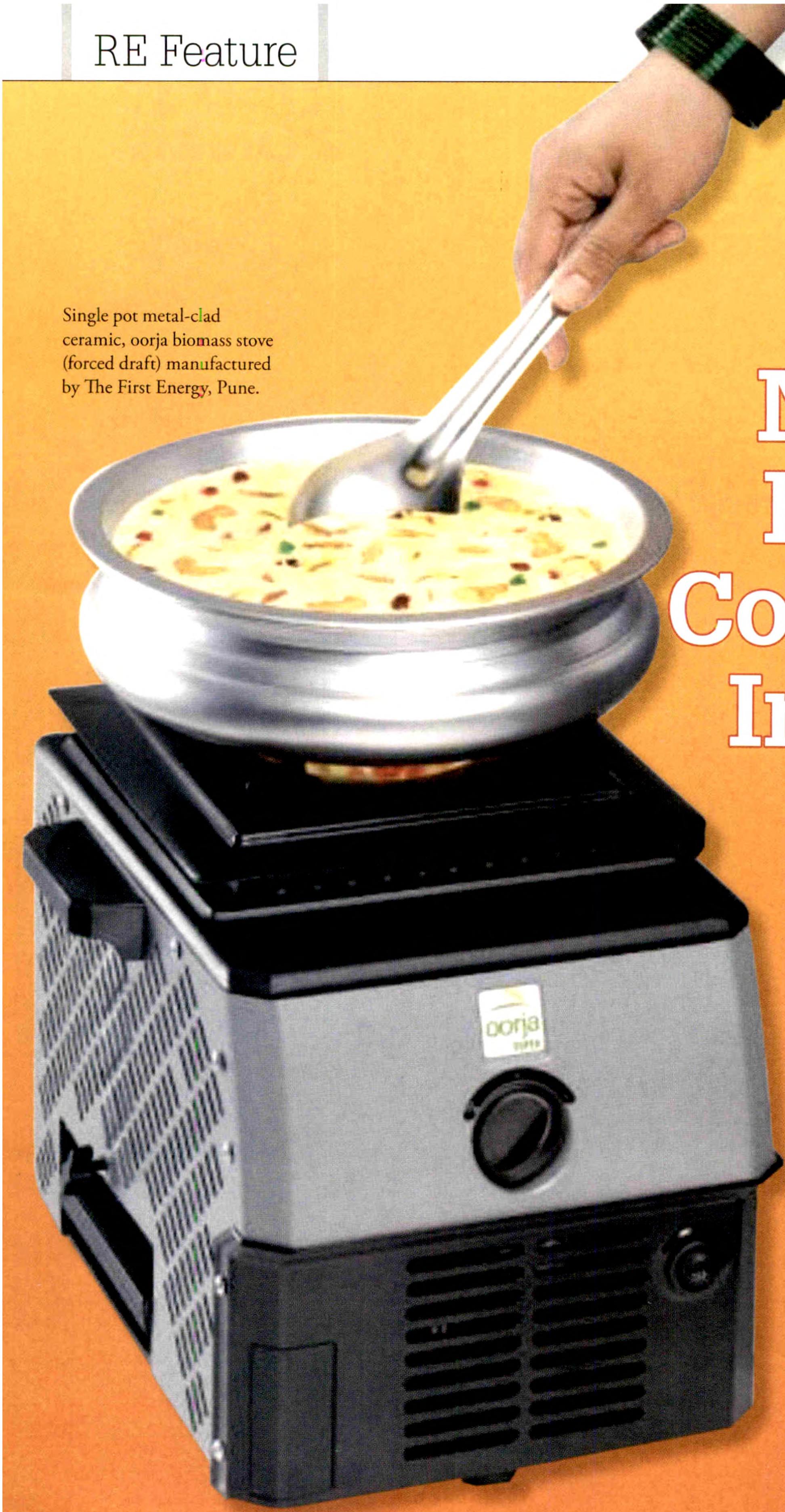


Single pot metal-clad ceramic, oorja biomass stove (forced draft) manufactured by The First Energy, Pune.

National Biomass Cookstove Initiative

(NBCI) – Cooking Energy Solutions and Sustainable Development

Improved biomass cookstoves have a tremendous potential for addressing cooking energy solutions in rural areas apart from addressing health hazard concerns and deforestation.

Dr Bijendra Singh Negi

In India, around 75 per cent of the rural population still uses traditional biomass as the main cooking fuel in traditional *chulhas*. Additionally, there are a large number of roadside eateries and other small/cottage scale rural enterprises that rely on biomass for meeting their energy requirement. Inefficient burning of biomass in traditional *chulhas* poses a serious health hazard especially in enclosed spaces, affecting the lives of a staggering number of rural people, in particular, women and children, and has serious implications on climate change. Further, unsustainable collection of fuel wood for cooking puts pressure on natural/forest resources and can hasten land degradation and other environmental problems linked to deforestation. Thus, improved biomass cookstoves have a tremendous potential for addressing cooking energy solutions in rural areas apart from addressing health hazard concerns and deforestation.

Ministry of New and Renewable Energy (MNRE) had implemented a National Programme on Improved Chulhas (NPIC) during 1983-84 to 2002-03. About 35.2 million improved cookstoves were disseminated under this programme, until it was transferred by the Planning Commission to the states. However, despite the potential, dissemination of biomass cookstoves did not catch the required attention as a cooking energy solution mainly due to lack of awareness, availability and inadequate thrust on use of biomass improved cookstoves in the development plans at the state level.

> **A National Biomass Cookstoves Initiative (NBCI) was launched by MNRE in 2009 with the aim to enhance availability of clean and efficient energy for energy deficient and poorer sections of the country.**

IMMT, Council of Scientific and Industrial Research (CSIR) Design. Single Pot Metallic Harsha stove (natural draft) manufactured by Unicus Engineering Pvt Ltd, Bhubaneswar.

National Biomass Cookstove Initiative

In view of recent developments in climate change impact and energy security concerns, MNRE under a Special Project on Cookstove (SPC) during 2009-10 initiated a process of consultation to review the status of various types of biomass improved cookstoves being developed and promoted by various organisations, non government organisations (NGOs), entrepreneurs and industry in the country. During the consultations, it emerged that biomass cookstoves have considerable potential to address health hazards and socio economic welfare concerns of the weakest and most vulnerable sections of society.

A National Biomass Cookstoves Initiative (NBCI) was launched by MNRE on 2 December 2009 at New Delhi with the primary aim to enhance the availability of clean and efficient energy for the energy deficient and poorer sections of the country. The new initiative recognised that cookstove technology has improved considerably in the recent years and the efforts need to be continued further to improve the designs to make them efficient and cost effective. The initiative laid emphasis on enhancement of technical capacity in the country by setting up state-of-the-art testing, certification and monitoring facilities and strengthening research and development (R&D) programmes in key technical institutions.

The NBCI was envisaged to be structured differently from the earlier NPIC, although it was to build on the successes of that programme while also drawing lessons from the experience gained from its implementation. Under this initiative, a series of pilot projects were envisaged using several existing commercially available and better cookstoves and different grades of processed biomass fuel. This would help in exploring a range of technology deployment, and biomass processing and delivery models leveraging public private partnerships (PPP).

Technology and Models of Cookstoves

The biomass cookstoves enable cooking in a smokeless condition with reduced fuel consumption and pollution.

Lack of understanding about the use of biomass as fuel in biomass cookstoves leads to dissatisfaction about the benefits of cookstoves in terms of reducing fuel and emissions.

A variety of solid fuels such as firewood, twig, leaf, dung cake, agricultural wastes, raw coal, briquettes, bagasse etc. can burn in the stoves with high thermal efficiency (30 to 50 per cent) irrespective of different physical and chemical characteristics of the fuel biomass. Cookstoves are of two types: fixed and portable. The portable cookstoves are also of two types: natural draft and forced draft. In recent years, a number of institutions/industries have developed advanced designs of biomass cookstoves utilising forced draft concept for better combustion of fuel. There is an IS Standard 13152 (Part I): 1991 on Solid Biomass *Chulha* by the Bureau of Indian Standards (BIS). The thermal efficiency of solid biomass cookstoves as per BIS should be more than 25 per cent, the CO/CO_2 ratio 0.04 or below, the total suspended particulate matter (TSP) not more than 2 mg per cu m and the body temperature not more than 70°C. The aforesaid standard is being used for performance testing and approval of various improved cookstoves in the country directly for single pot metallic cookstoves and as a guideline for other types of cookstoves for performance evaluation.

Approved Models of Cookstoves

Natural draft and forced draft models of single part metallic and metal plate ceramic (ceramic composite/ industrial insulating materials) cookstoves have been developed and are being manufactured in the country. Some of the models have been approved by MNRE on the basis of their testing conducted by the Ministry supported Biomass Cookstove Test Centres following the existing BIS standard available for single pot metallic cookstoves. Forced draft cookstoves have shown better efficiency (38-40 per cent).

Recent Initiatives

Pilot Scale Demonstration Projects

The critical issues in adoption of a biomass cookstove are the choice of users, ease of use and maintenance and conformance to local cooking habits across the country. Another important aspect is that its adoption must make economic sense to the households. Pilot projects have been taken up for demonstration and to study the field performance of both - family type cookstoves and larger capacity community cookstoves. These have included the response of users, operation and maintenance aspects at local level and a study of the impact on fuel saving, emission reduction, indoor air quality and health hazards. The starting point for the project has been to select cookstoves which have been tested in the biomass test centres and whose performance was found conforming to existing BIS. Special care has been taken to consider the kind of biomass resource available at local sites. The objectives of the pilot demonstration projects were:

(i) to demonstrate the use of improved biomass cookstoves for providing cleaner cooking energy solutions; to study their impact on social and economic development, fuel saving, emissions resulting from burning biomass including indoor air quality and mitigating drudgery and addressing health related concerns of women and children who have been using the traditional *chulha* for cooking;

(ii) to demonstrate the impact of using biomass improved cookstoves on mitigating climate change by reducing the carbon and other emissions resulting from burning biomass for cooking; and

(iii) to gather field performance data for preparing a strategy for expansion of deployment of biomass cookstoves, including exploring clean development mechanism (CDM) benefits to improve the affordability of biomass cookstoves.

I. Pilot Scale Community Cookstoves

A project 'Pilot Field Testing and Evaluation of Community Sized Biomass Cookstoves' has been taken up during 2010-11 for demonstration of community cookstoves for community applications in 8 identified states in the country. The project has been completed and the final report is awaited from Indian Institute of Technology (IIT) Delhi. Field performance monitoring has been carried out to study the performance and shortcomings during operation of the cookstoves. It has been observed that lack of understanding about the use of biomass as fuel leads to dissatisfaction about the benefits of the cookstoves in terms of reducing biomass fuel and emissions. The field performance data taken on 'proper' use of cookstoves indicated fuel saving of around 40-50 per cent, emission reduction of about 60-70 per cent and saving of cooking time by about 30 per cent. Another pilot scale project for demonstration of 5,500 biomass community cookstoves in Anganwadis, mid-day meal schemes in schools, tribal hostels, *dhabas*/restaurants and other commercial establishments has been taken up during the current year under the Government of India's (GOI) Clean Energy Fund to study the impact of deployment of larger size of cookstoves on fuel saving, emission reductions, etc. The financial support for the project under National Clean Energy Fund (NCEF) is restricted to 40 per cent of the cost of the project. The field performance evaluation will be carried out to study the various aspects for developing a strategy for large scale deployment in future. Only cookstoves tested at MNRE Biomass Test Centres and performance found satisfactory as per BIS will be considered for deployment.

II. Family Sized/Portable Biomass Cookstoves

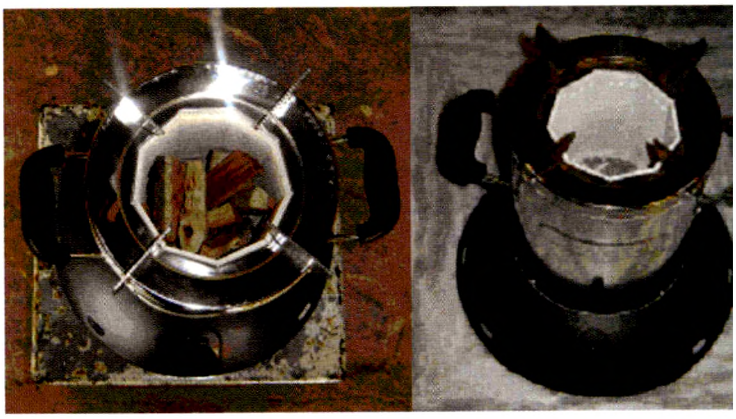
There is a tremendous potential for replacing traditional *chulhas* with the improved biomass cookstoves in the household sector in rural areas. The Ministry has proposed to take up a pilot project on the demonstration of 15,000 family sized/portable cookstove during 2011-12. The financial assistance for the project will be restricted to up to 50 per cent of the cost of biomass cookstoves. The pilot project will be implemented through state nodal agencies, experienced NGOs, Self Help Groups (SHGs), manufacturers or entrepreneurs having sufficient experience at grassroots level for implementation of renewable energy projects. Only models tested successfully in test centres will be selected for the project.

The overall monitoring and evaluation of the demonstration project will be supervised by a core group on biomass cookstoves, but the field monitoring will be carried out with the help of a third party monitoring system. Indoor quality measurements will be carried out by the concerned zonal biomass cookstove test centres to make an overall assessment of impact of use of cookstoves on indoor air quality for a few locations. The feedback of the project will be used for developing a strategy for deployment of biomass cookstoves for the 12th Five Year Plan.

Performance Testing and Standards

The Ministry received requests from a few industries to grant excise duty exemption on the cookstove models manufactured by them. In order to maintain quality of the cookstoves, these models were to be tested for their performance as per stipulated procedure to conform to the required parameters. Subsequent to the launch of the NBCI, interaction with R&D institutions/organisations which were earlier engaged in testing of cookstoves were encouraged to strengthen their test facilities so that cookstove models could be tested for their performance as per standards set by BIS. The cookstoves are being tested for 3 performance parameters - thermal efficiency, emission ratio of CO/CO_2 and total suspended particulate matter.

> **There is a tremendous potential for replacing traditional chulhas with the improved biomass cookstoves in the household sector in rural areas.**



Philips (HD 4012) forced draft metal-clad-ceramic lining biomass stove manufactured by Elin Electronics Ltd, Ghaziabad.

Three test centres have been taken up and funded by MNRE to cater to the requirements of testing of cookstove industries for different zones in the country. At IIT Delhi for the north zone, at Maharana Pratap University of Agriculture Technology (MPUAT), Udaipur for the western zone and at the Institute of Minerals and Materials Technology (IMMT), Bhubaneswar for the eastern zone. Three cookstoves have been granted excise duty exemption on the basis of satisfactory performance in their tests in testing centres during the year 2010-11. Two others have been asked to improve their designs.

Test Protocols and Standards

In recent years, advanced cookstoves have been developed by some R&D organisations/industries. These cookstoves use the forced draft concept for efficient combustion. In the light of newer designs that became available, the applicability of the existing standard on solid biomass *chulha* which was brought out by BIS in 1991 was examined and a revised draft standard and test protocols were developed to cover all types of biomass cookstoves (both portable and community type). The revised draft standards have been prepared and forwarded to BIS for further action/approval.

> **The foremost challenge in terms of large scale deployment of the improved biomass cookstoves lies in understanding the dynamics of stove adoption by end users.**

Biomass Cookstoves Deployment Perspective

Challenges and Opportunities for Large Scale Deployment

(a) R & D and Technology development

Though a variety of designs have been developed in recent years, the performance evaluation carried out at test centres have revealed that cookstove designs require improvement particularly in the combustion chamber and insulation. Therefore, R&D in improved biomass cookstoves is required to increase thermal efficiency with cost effectiveness. Apart from this, R&D is also required on pelletisation of biomass waste, which helps in increasing the calorific value of the input fuel while reducing the ash and moisture content. However, stabilisation of pelletisation technology itself offers a challenge because of the diverse nature of biomass waste, its combustion characteristics and availability. Both these aspects of R&D are important in terms of increasing the efficiency of the cookstove and ensuring uninterrupted supply of improved quality fuel.

(b) Large scale deployment

The foremost challenge in terms of large scale deployment of the improved biomass cookstoves lies in understanding the dynamics of stove adoption by end users at the household and commercial level, especially in terms of ease of usage, reduced fuel use, efficient performance, and better indoor air quality. Another important aspect of large scale deployment is creation of awareness and training for operation and maintenance at local level. Further, in the case of forced draft type biomass cookstoves, the stoves need processed fuel (size, density, moisture etc.) in order to meet the desirable values for combustion efficiency and emissions. One of the major requirements for large scale deployment of these stoves in rural and peri-urban areas is to set up decentralised, affordable fuel supply linkages around the target areas. While the available woody fuel can be cut and sized to suit the requirement of the stoves, it is desirable to move away from wood due to considerations of deforestation, unsustainable use etc. The available agro-residues are estimated to be 600-740 million tons per year (2005-06) and the surplus biomass is estimated to be about 160 million tons per year. Hence, agro residues or refuse derived fuel (RDF) would be the potential candidates for stove fuels. The various types of agricultural biomass around the country, which are generally available as loose biomass, will thus, have to be converted into pellets or briquettes to be effectively utilised in these stoves.

Networking and collaboration among key stakeholders at central, district and local level will need to establish to support large scale diffusion and deployment required for up scaling improved cookstoves especially in terms of dealing with training, capacity building, awareness generation and

Central Power Research Institute (CPRI) Design. Single Pot Metallic Vikram Biomass Cookstove (natural draft) manufactured by Vikram Stoves & Fabricators, Osmanabad, Maharashtra.

financing needs. Further the users' education, training, awareness and information dissemination strategy are required to be properly integrated with the target group for creation of demand.

(c) Financing

The support in terms of financial assistance/subsidies provided for up scaling the cookstove can make the technology affordable, but ultimately diminish the value placed on them by the users. Direct end user subsidy needs to be discouraged for the continued use of improved cookstoves and the sustainability of the programme. The challenge is to make affordable credit available to allow more number of households/ commercial entities to shift towards improved cookstoves. Microfinance programmes with instalment options can help solve this problem to a large extent.

Opportunities

(a) Availability of Grassroots Level Delivery Channels

Practical lessons from the past efforts and other ongoing programmes present newer opportunities to introduce improved cookstoves with a better understanding of the challenges and improved planning. The improved cookstoves programme requires to be demand driven and need based. Also there is a need for thorough networking and collaboration among key stakeholders - the women. Thus, the benefit of improved cookstove programme in terms of generating local employment and income opportunities can become the starting point for roping in women SHGs. This will help in putting in place a delivery channel that is demand driven and also offer an opportunity to get feedback from end users on technology development and diffusion strategy based on local conditions, requirements and demand. SHGs and their federations can also be used as a vehicle for capacity building, training, awareness, education and information dissemination for targeted stakeholders.

(b) Microfinance

Availability of affordable credit for households/ small commercial entities assumes tremendous importance for the deployment of an improved cookstove programme at a large scale. SHGs involved in thrift and credit activities can be used to promote microfinance at the local level thereby making low cost credit available to targeted households and business entities at their door step.

> **Practical lessons from the past efforts and other ongoing programmes present newer opportunities to introduce improved cookstoves with a better understanding of the challenges.**

Carbon Finance on Biomass Cookstoves

The cookstoves market is still at a nascent stage and manufacturers have had limited opportunities to realise economies of scale to be able to offer lower prices to consumers. While subsidies could be an option to increase affordability for the most disadvantaged, offering similar pricing structures to the market at large may be unrealistic. Against this background, it was recognised that carbon finance may offer an additional alternative for reducing the price and increasing the affordability of improved biomass cookstoves for low income households. Switching to biomass cookstoves can displace greenhouse gas (GHG) emissions related to fuel use. Encouragingly, carbon offsets generated from cookstove projects are reportedly among the most sought after among voluntary offset purchasers. With this consideration, the Ministry has initiated the process of developing a Programme of Activities (PoA) for CDM in biomass cookstoves.

Conclusion

Improved biomass cookstoves have tremendous potential for addressing cooking energy needs in rural area, apart from saving biomass fuel and addressing health hazard concerns, particularly amongst women and children. The field performance study of pilot scale projects will help in creating publicity and awareness and in developing strategy for large scale deployment including business models for cookstoves in the country. However, R&D efforts need to be pursued vigorously, parallelly to develop efficient and cost effective cookstoves. Effectively, industry and R&D institutions have to work together to improve the designs of cookstoves. The test centres have a strong role to play not only in performance testing but also in identifying the areas for research for improvement in cookstoves designs. ❂

The author is Director (R&D Coord. and NBCI), Ministry of New and Renewable Energy, New Delhi. E-mail: negi@nic.in

IDBG COOK STOVE

Improving Efficiency and Environment of Rural Kitchens

Sardar Patel Renewable Energy Research Institute, Anand has developed an Inverted Downdraft Biomass Gasifier cook stove which has the potential to bring about significant savings in fuel wood, improve the kitchen environment and mitigate the concerns of global warming.

Sunil Narnaware and **Devendra Pareek**

A major part of the rural population in India depends on biomass like waste agro-residues, wood, cow dung etc. for their cooking needs. A wide variety of cook stoves have been developed worldwide for combustion or gasification of biomass and these burn the fuel 2-3 times more efficiently than the traditional stoves. Around 100 designs of improved cook stoves developed across the globe have been documented and discussed in www.bioenergylists.org. These cook stoves are made of metal, mud, and various refractory materials and many of them are provided with a chimney. In the past, cook stoves with a chimney were considered superior to chimneyless stoves because the flue gases were discharged out of the kitchen. Keeping in view the concern of global warming, it is important that the emissions from the improved stoves selected for mass popularization should also be as low as possible. In keeping with this, an Inverted Downdraft Biomass Gasifier (IDBG) stove has been developed at Sardar Patel Renewable Energy Research Institute (SPRERI), Anand. The design principle of reverse down draft gasifier stove has been discussed by Reed and Larson ('A wood-gas stove for developing countries', 1996) and the same has been adapted for designing the stove.

Construction detail

The main body of the IDBG cook stove consists of a cylindrical shell made from 2 mm thick mild steel sheet. The inner diameter and height of the shell are 215 mm and 450 mm, respectively. The inner surface of the shell is provided with a 25 mm thick layer of insulite-7 to significantly cut heat losses from the burning fuel bed. Provision to control the amount of primary air supply for combustion has been provided at the bottom of the stove. For safety of the people working close to the stove, a protective metallic net has been provided all around the outer shell of the cook stove. Due to this, the hot metallic surface of the cook stove becomes accident proof. The construction details, major components and important dimensions of the IDBG cook stove are given in Fig 1.

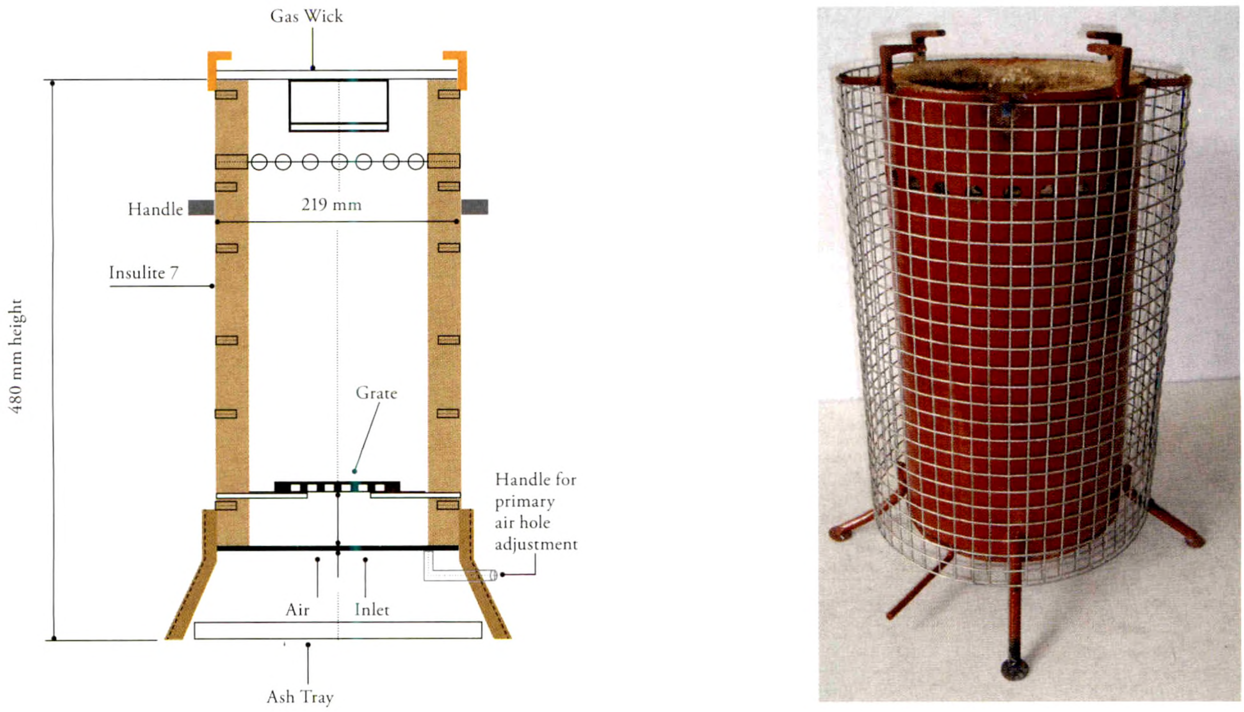
> **The hot gases rise upward under chimney effect. Therefore, in this design of the IDBG, a fan or blower is not required for the supply of air.**

Working Principle

The IDBG cook stove is primarily designed for operation in batch mode. The fuel is lit and ignited from top of the stove. Due to heat of the burning fuel layer at the top, the layer just below the burning bed gets heated up and releases the pyrolysis gases. The gases burn using the air drawn from the bottom of the stove. The burning zone, called flaming pyrolysis zone, continuously moves downward and utilises the available unburnt fuel.

During operation, primary air is drawn through an adjustable opening provided at the bottom of the stove. The air passes through the bed of burning wood pieces and carries with it the volatiles, leaving the charcoal. The resulting gas passes through the charcoal available in the upper zone and is reduced to a low energy fuel gas. The hot gases rise upward under chimney effect. Therefore, in this design, a

Fig 1. Construction details and photograph of IDBG cook stove developed at SPRERI

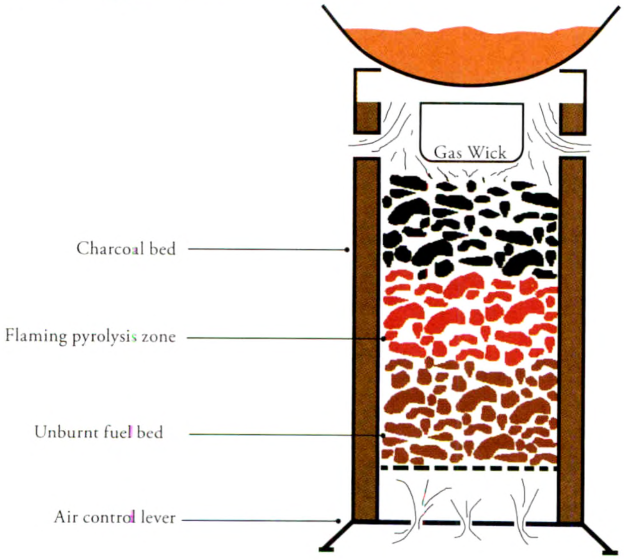


fan or blower is not required for the supply of air. Under normal operating conditions, the top layer contains charcoal, the intermediate layer is the flaming pyrolysis zone and the bottom layer contains unburnt fuel as shown in Fig 2. This arrangement is a reverse of the sequence generally found in a typical down draft gasifier. Therefore, IDBG is sometimes also referred to as reverse down draft gasifier, where air is supplied from the bottom and the gases come out from the top. The holes provided all around and below the upper end of the shell supply necessary secondary air for combustion of the flue gases. The gas wick, provided at the upper end of the shell, helps in development of additional draft and distributes the flame all around the cooking pan. The fuel burning rate is controlled by operating a lever that varies supply of the primary air to the fuel bed from the bottom of the stove.

Testing at the institute

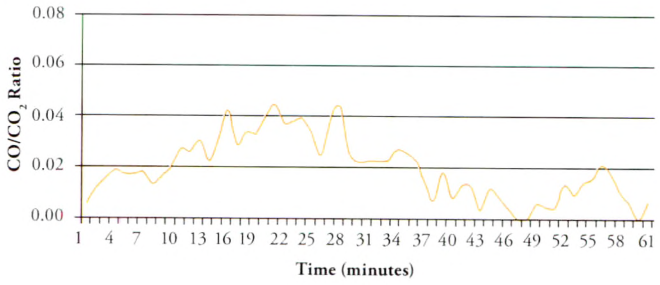
The laboratory tests for thermal efficiency and emission were carried out at the institute during 18-30 July 2011. Ambient temperature during the period generally varied between 30 and 35°C. The thermal efficiency of the cook stove was determined using standard water boiling test and emissions were measured with the emission hood method as per Bureau of Indian Standards (BIS) norms. The vessel size and quantity of the water were also taken as per BIS norms. The emissions were measured using portable flue gas analyser with infrared sensors for CO and CO_2 measurement. Approximately 1 kg sized mango wood (*Magnifera indica*) pieces (3 cm × 3 cm × 3 cm) having moisture content 6-7 per cent (wet basis) were charged at a time. For quick ignition, around 10-15 mm of kerosene oil was sprinkled over the fuel bed. After ignition, the once charged fuel lasted for 55 to 60 minutes. The experimental setup consisted of the IDBG cook stove, a chimney, portable flue gas analyser, thermometer, cooking pan of appropriate size and K-type thermocouples with indicator. Five replications of the tests were carried out and average values have been reported. The thermal efficiency of the stove was found varying between 35 and 39 per cent, which is more than 10 per cent higher than the minimum value as per the recommended value given by Ministry of New and Renewable Energy (MNRE) for biomass cook stoves. The ratio of CO/CO_2 computed for the stove is given in Fig 3. It can be seen that during most of the operation period, the CO/CO_2 ratio is below 0.04, which is well within permissible value prescribed by MNRE. The temperature of the protective metallic net was below 50°C during entire experiment period.

Fig 2. Working principle of IDBG cook stove



> **IDBG is sometimes also referred to as reverse down draft gasifier, where air is supplied from the bottom and the gases come out from the top.**

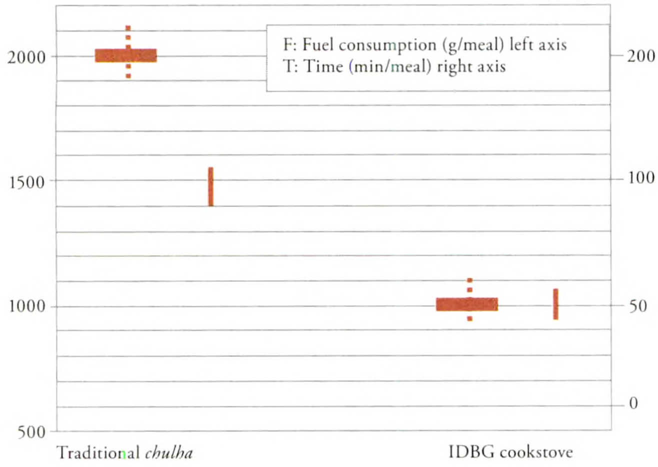
Fig 3. CO/ CO_2 ratio for IDBG cook stove



Evaluation at user's site

Encouraged with the excellent performance of the stove during the laboratory tests, one stove was installed in a rural kitchen at village Karmasad, Anand District, Gujarat. The family consisted of a young couple and two school going children. Until then the family was using a traditional three brick stove for all cooking i.e. preparing tea, snacks, meals and water heating etc. To begin with, data on cooking time and fuel consumption were collected for using the traditional stove. The lady of the house was given necessary training (including adaptation period) in use of the IDBG stove. Thereafter, data were collected for cooking similar meals using the IDBG stove and cut branches of babul wood (*Prosopis juliflora*) of 5-10 mm dia. and 3-6 cm length as fuel. The data collected revealed that there was a savings in fuel consumption by 40-47 per cent and in cooking time by 30-51 per cent for cooking rice, potato curry and chapatti using the IDBG stove as compared to cooking same items using the traditional 3 bricks cook stove, as shown in Fig 4. Use of wet fuel wood containing more than 15 per cent moisture, in IDBG stove, resulted in emission of smoke during the startup. As soon as the fuel started burning emissions reduced significantly and the environment in the kitchen turned satisfactory even during the rainy season.

Fig 4. Performance of traditional vs. IDBG cook stove at user site for cooking similar meals



User feedback

The IDBG cook stove was installed at the selected user's house during peak rainy season, the most troublesome period for use of biomass based stoves, and the feedback was collected from the lady of the house after about one month. It was reported that the cook stove was used for all cooking and food warming applications, that it was easy to operate, saved fuel and reduced the cooking time. The residual heat was retained for a long time and was useful for keeping the food and water warm. However, the user reported that cooking with large sized utensils was little inconvenient because of the height of the stove, which she managed using a small stool for seating while cooking. The family had stored fuel wood logs for the entire rainy season. The wood logs were cut into small pieces for use in the IDBG stove. The family sometimes used the traditional 3 brick stove primarily because the available fuel wood logs could not be reduced to small pieces due to continuous rains. The user stated that she saved fuel and completed cooking in a shorter time span but could not quantify the parameters. She also informed that, if necessary, the cooking duration was extended beyond the batch operation by feeding additional wood pieces from the top. The red flame, however, indicated that the mode of fuel burning had turned to combustion. Overall the family appeared satisfied with the IDBG stove.

> **The laboratory testing on the IDBG cook stove revealed that its thermal efficiency is 10-15 per cent higher and emissions are within the limit set by MNRE for the biomass cook stoves.**

Cooking with IDBG stove

Conclusion

The laboratory testing of the IDBG cook stove revealed that its thermal efficiency is 10-15 per cent higher and emissions are within the limit set by MNRE for the biomass cook stoves. The village woman, who was provided with the IDBG stove, regularly used it for all cooking purposes even in the rainy season and endorsed its usefulness for meeting her cooking needs. ❂

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Multi-stakeholder Analysis of Biodiesel

System in Rajasthan and Orissa

The article attempts to analyse the feasibility and success of Jatropha based biodiesel production and consumption in the state of Orissa and Rajasthan based on primary surveys and analysis of secondary data.

Jyoti Parikh, **Dinoj Kr Upadhyay** and **Abhay Siddham**

Access to clean energy at an affordable price is a prerequisite for sustainable development and progress as well as the well being of human beings in the contemporary world. Since the inception of human civilization, nature and sources of energy have constantly been diversified and innovated and countless natural and human factors have shaped the process. In the current context, ever rising energy demands and often galloping global crude prices, technological advancements, need to contain green house gases (GHGs) emissions and diversify energy supply sources, etc. are some of the reasons for promoting production and use of biofuels as an energy source across the world. From an Indian perspective, diversifying energy sources, augmenting domestic supply sources, reducing local emissions, contributing towards reduction of foreign exchange outflow and improving the livelihood and income generation opportunities in rural areas especially in the semi-arid regions are additional factors for promoting biofuels.

Biodiesel Scenario in India

In India, sugarcane based ethanol is used as a petrol substitute and oils from Jathropa and other oilseeds are used as diesel substitutes. The National Mission on Biodiesel was launched in 2003 to address the socio economic and environmental concerns in India. The Mission was proposed in two phases: Phase 1 - demonstration project by 2006-07 with an investment of INR 1500 crore on 4,00,000 ha. Phase 2 - self sustained expansion by 2011-12. At present biodiesel production is negligible and the results of this ambitious plan are awaited. The biodiesel production efforts are focused on using non-edible oils from plants (*Jatropha curcas, Pongamia pinnata* and other tree borne oilseeds) and animal fats like fish oil. The focus is to encourage the use of wasteland and other unproductive land for the cultivation of these relatively hardy biofuel crops. The Government of India (GOI) wishes to avoid biofuel feedstock crop cultivation competing with food crops for scarce agricultural land and water. India has an estimated 55.3 million ha considered as wasteland, which could be brought into productive use by raising biodiesel crops. However, problems in terms of availability, technical rights, suitable climate, agro ecologic conditions and water availability, etc. need to be overcome.

Feasibility Scenarios of Biodiesel in Rajasthan and Orissa

It has been noted that promotion of biofuels in general and biodiesel in particular is a very complex issue and is dependent on various factors like knowledge, infrastructure support, policy issues, political environment, inter-sectoral and international cooperation, technology promotion and transfer. The feedstock supply and management chain emerge as a major issue to be addressed considering local circumstances such as climatic, agronomic, economic, and social conditions. To assess the feasibility scenario in Rajasthan and Orissa, a survey was conducted in 41 villages to interact with the Jatropha cultivators.

Land and Climate

In Rajasthan, only 52 lakh ha of the total 1014.5 lakh ha of wasteland is considered cultivable, this includes the desert, sand dunes and red desert soils in the western part and the red soils and alluvial in depressions of foot hills in the southern part. The texture varies from sandy, coarse sand, sandy loam, to gravel. The average rainfall varies across the state and generally an annual rainfall of 100 mm is received. Though Jatropha can grow under such conditions, the growth is affected due to scarcity of water. A wide variation in temperature from -2°C (in north western) to 45°C in south eastern region is observed in Rajasthan and the low temperature is not considered suitable for the Jatropha crop.

Jatropha plantation in Rajasthan was initiated as early as 2001 but actual large scale plantation began only from 2006 onwards. No specific figure on actual area under plantation in the state is available.

In Orissa, 18 lakh ha of wasteland is available where no cropping is possible due to degradation, undulating terrain, erosion and low fertility. The soil offers a wide range of variation from lateritic, red and yellow and mixed red and black. These soils are either acidic or alkaline in nature, thereby limiting the possibility of raising any normal agriculture crops. The state receives a fairly good rainfall of around 1500 mm, including the summer. These climatic conditions are favourable for the Jatropha plantation for which availability of water during the early stages of growth plays a critical role. The temperature in all the agro-climatic regions of the state ranges between 12 and 40°C, which is ideal for the growth of Jatropha except in major parts of Koraput and Nabarangpur where the winter temperature drops down to 7.5°C. Therefore, the project study notes that climatic conditions are far better for the Jatropha plantation in Orissa than in Rajasthan.

Jatropha Plantation

Jatropha plantation in Rajasthan was initiated as early as 2001 but actual large scale plantation began only from 2006 onwards. No specific figure on actual area under plantation in the state is available, though a number of private players and government agencies are independently involved in the activity. Some farmers are also cultivating Jatropha on

'Seeing is believing', holds true in Orissa. Given the good growth performance of the demonstrative plantations, many farmers have taken up cultivation of Jatropha on their waste/fallow lands.

agricultural land under contract farming, but the growth of plants is slower as compared to Orissa because of water scarcity and climatic conditions.

In Orissa on the other hand, large scale plantation activity was initiated in 2007-08. The State Government has planned to cultivate more than 15,000 acres and the Orissa Nature Care Council Action (ONCC) has planned to cover 100,000 acres by 2013.

In Rajasthan, the yield is very low, ranging from 250-400 gms per plant even after more than four years of plantation. In Orissa, it is a little early to comment on the yield, however given the good growth, better yields are expected compared to Rajasthan. Therefore, though Jatropha survives in extreme conditions its performance is negatively impacted by scarcity of water in the early stages of growth.

Cultivators

Enthusiastic participation of farmers for Jatropha plantation was observed in Rajasthan where the State government supports plantation activity through various programmes. Many of the private sector companies are promoting plantation through contract farming mode.

'Seeing is believing', holds true in Orissa. Given the good growth performance of the demonstrative plantations, many farmers have taken up cultivation of Jatropha on their waste/fallow lands. A unique model of Self Help Group (SHG) based Jatropha plantation has been established in the State.

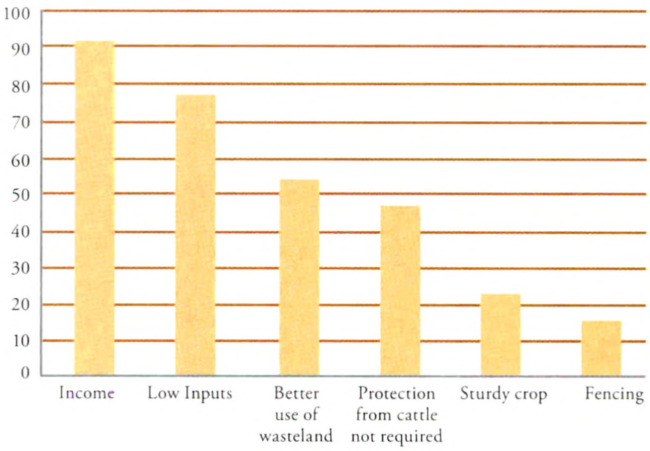
The project study noted that the major driving factor in both the states were the additional economic benefits from the use of available wasteland. However, other reasons like low input cost, support from local organisations, the crop being sturdy, no requirement of protection from stray cattle, have also played an important role in the adoption of Jatropha for plantation. It was noted that a proper institutional support system is needed for establishing linkages with financial institutions, government organisations and the market.

Farmer's Perception

To understand the reasons for farmers choosing to plant Jatropha an analysis of the project data was undertaken.

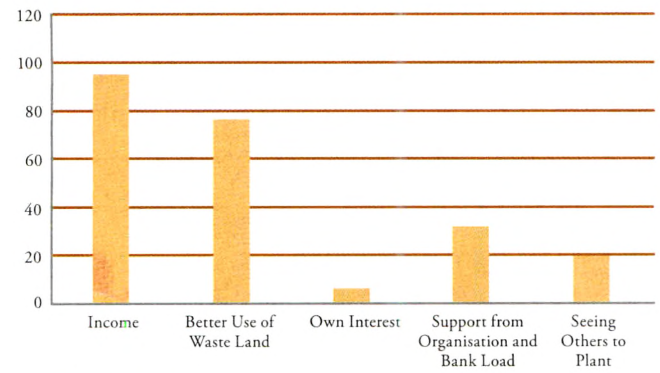
In Rajasthan, 92 per cent farmers cited economic benefit as the main reason, while 77 per cent cited low inputs as another reason and 54 per cent said it is the best use of their wasteland. Quite interestingly, 46 per cent farmers reported that they planted this crop because it does not require any protection from stray cattle, which is a problem in Rajasthan. This is also a reason for using Jatropha as a fence crop (Fig 1).

Fig 1. Farmer's Perception of Jatropha Plantation in Rajasthan (Percentage)



While in Orissa, 96 per cent farmers cited economic benefit as the main reason, and 77 per cent thought this was the best use of their otherwise wasteland. An important aspect for the promotion of the activity in the State was that 32 per cent farmers said they adopted it since there was support from local organisations. 19 per cent farmers said they were motivated to adopt Jatropha by seeing the plantations of other farmers. The survival rate of plants in Orissa is good and the farmers believe that the government provides adequate support.

Fig 2. Farmer's Perception of Jatropha Plantation in Orissa



Source: IRADe Survey

Processing: Extraction and Trans esterification Industries

The assurance by the Government of Rajasthan to support processing units is yet to materialise since the production levels are not yet adequate for a large scale processing plant, therefore existing expellers are used for the extraction of the oil. A private company, IKF Technologies Limited has established a biofuel refinery in Udaipur and its capacity will be expanded to 100 MT in the future. The Rajasthan State Mines and Minerals Limited has set an example by establishing a small scale refinery, while the Maharana Pratap University of Agriculture and Technology, Udaipur has also established two Jatropha oil processing plants - in Dungarpur and Udaipur.

The Orissa Forest Development Corporation had installed one integrated biodiesel plant at Satyanagar, Bhubaneswar in 2007 to demonstrate the complete process from extraction to trans-esterification.

Marketing

In Rajasthan, though the plantation is older than in Orissa, production levels are not up to the mark to achieve sizable trading. Seeds are mainly sold in the local market and traded at prices ranging from INR 3-10 per kg even though the government had assured a minimum support price of INR 7 per kg.

In Orissa since the plantation is new, significant market landing for the Jatropha seeds was not observed in the local market. It may take another year or two to establish trade linkages. ONGC has assured buyback at the rate of INR 5 per kg to the farmers.

In both the States, no such arrangement exists for trading seeds or oil/ diesel at the regional level. Since the supply side has not yet been established, the end users are still to benefit from Jatropha - it is only used on an experimental basis by institutes and not available in the market for general public use as biodiesel.

Institutional Support

In both States, some institutional mechanism has been established to provide credit, risk assessment and loans to cultivators. The governments have been providing training and capacity building support. The banks have also been engaged in providing credit to the farmers.

Recommendations

Although Jatropha plants can survive in wastelands/ degraded lands, the fruiting and seed yield of the plant is highly dependent on availability of water (rain or irrigation) during critical growth stages. Soil characteristics also play an important role in the growth. Therefore, it is observed that the growth performance is better in Orissa than in Rajasthan. Jatropha plantations are in early stages of development in both the States and actual results on the production are awaited. There is a need to record 'time series performance' of the plantations in the States to understand the impact of various factors influencing the production.

Timely availability of quality planting material is very important for the promotion of Jatropha, therefore a proper quality control mechanism should be established and research and development (R&D) efforts should be initiated to provide good planting material. Nursery establishment should be given priority. The support system for training, resource mobilisation (both inputs and financial) and information exchange for the farmers needs considerable strengthening. This could be done by building suitable institutional support mechanism with the support of NGOs and private institutions. Formation of SHGs and tie-ups with financial institutions will create a positive impact on promotion of this activity. Even though the area under Jatropha plantation has increased, it has not achieved critical production levels to enable establishment of large processing units. However, this could be the right time to establish oil expellers of small and medium capacity. Nurseries at cluster/ block level could help provide good quality saplings at the right time. ✪

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Sewage Gas Based Power Generation at Sewage Treatment Plants

Surat Municipal Corporation, Surat

Conceived in January 1997, this prestigious project of Surat Municipal Corporation was the first of its kind in India to generate green energy from sewage gas besides attempting to reduce emission of green house gases into the atmosphere.

M K Das

As a front runner in responding to environmental concerns, the Surat Municipal Corporation (SMC) initiated a proposal with the Ministry of New and Renewable Energy (MNRE) for productive use of the energy rich constituents of the sewage gas emanating from the existing digesters at the Anjana Sewage Treatment Plant (STP), Surat. Under the umbrella of the national programme on Energy Recovery from Urban and Industrial Wastes, MNRE had been promoting and financially supporting demonstration projects involving recovery of energy from wastes of a renewable nature, besides attempting to reduce emission of green house gases (GHGs) into the atmosphere.

Conceived in January 1997, a blue print of the project was prepared by SMC and tabled for scrutiny before the MNRE in July 1997. This early initiation led to in-principle agreement between the MNRE and the SMC to co-steer the project, subject to scientific confirmation about its techno-commercial feasibility and viability. Once the go-ahead for setting up the project was given, it was agreed that financial assistance of up to 50 per cent of the total project cost would be provided as grant by MNRE.

The prestigious project, first of its kind in India, to generate green energy from sewage gas was based on the use of an imported, 100 per cent sewage gas based engine of Spanish origin, duly complemented with high levels of automation and a state-of-the-art polymer based inflatable gas balloon. To oversee the activity of the project, SMC constituted a Project Implementation Committee of leading consultants from the academia and industry. The completely integrated plant successfully generated 500 kWe during the trial runs in October 2003. The present generation of electricity from the plant is about 8000 to 9000 units per day, which is consumed to run Anjana STP itself.

After successfully commissioning this prestigious plant the SMC took quick actions to setup other sewage gas power plants at the 3 STPs at Singanpore, Karanj and Bhatar. These STPs are set up on the Conventional Activated Sludge process. Sewage gas is being generated in these sewage treatment plants by the process of anaerobic digestion.

Brief Description of the Plant

The major components of the plant include a gas collection, a gas cleaning, a gas storing, a conversion and excess gas flaring systems.

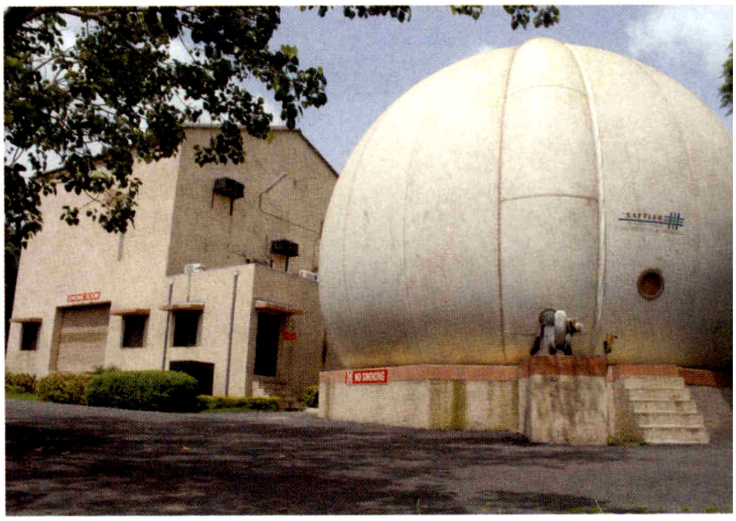
Biogas Collection System

There are 3 conventional, slow rate anaerobic sludge digesters, which generate @ 6200 - 6600 cu m per day of biogas. Twin lobe type root blowers operated with variable speed drives are provided to collect the biogas from the digesters and to transfer the gas to the scrubber and into the polymer based gas balloon. Evacuation of biogas from the digesters is controlled by the gas pressure developed in the digesters.

H_2S Scrubber

Biogas collected from the digesters contains hydrogen sulphide (H_2S). To minimise H_2S, the biogas is passed through a twin tower chemical scrubber constituting a packed bed column supplemented by a ventury jet column. This scrubber is designed to scrub the biogas to reduce the H_2S level to 500 parts per million (ppm) at the outlet of the scrubber. NaOH is used as a scrubbing solution and online H_2S analysers are provided at the inlet and outlet of the scrubber.

> **The completely integrated plant successfully generated 500 kWe during the trial runs in October 2003. The present generation of electricity from the plant is about 8000 to 9000 units per day.**



Sewage gas holder

Double Membrane Type Sewage Gas Holder

There is a double membrane type sewage gas holder made of highly tear resistant polyester fabric with a special polyvinyl chloride (PVC) surface treatment and acrylic

Technology Involved

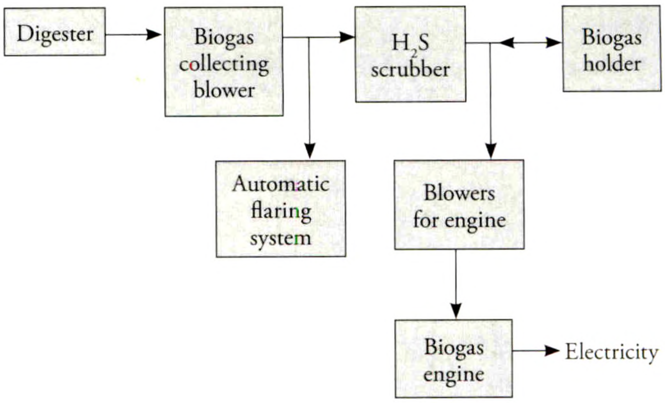


Table 1. Sewage gas based power generation at Anjana, Karanj, Singanpore and Bhatar sewage treatment plants of Surat Municipal Corporation, Surat - comparison of various parameters.

	Anjana	**Karanj**	**Singanpore**	**Bhatar**
Installed capacity of power plant (MWe)	0.5	1.0	1.0	1.0
Year of commissioning	October 2003	March 2008	March 2008	March 2008
kWh units generated since commissioning (till July 2011)	13993185	8945890	6319167	3020428
Generation (in Rs till July 2011)	6,01,85,634	4,19,49,174	2,96,30,694	1,42,43,571
MATERIAL BALANCE				
Biogas Contains				
CH_4 (per cent)	67 to 68	60 to 75	60 to 75	60 to 75
H_2S	80 ppm	< 1 per cent	< 1 per cent	< 1 per cent
CO_2 (per cent)	28 to 30	25 to 36	25 to 36	25 to 36
N_2 (per cent)	< 0.2	< 0.2	< 0.2	< 0.2
Moisture	balance	balance	balance	balance
Net calorific value (kcal per N cu m)	5600	4700 - 6200	4700 - 6200	4700 - 6200
Biogas generated from digester (cu m per day)	4900	4500 - 6200	4200 - 5200	4200 - 5400
Biogas consumed by engine (cu m per day)	4800	--	--	--
Biogas stored in gas holder (cu m per day)	100	--	--	--
Electricity generated (kWh per day)	8300	9900 - 13500	9200 - 11200	9200 - 11800
Air consumed by engine (cu m per day)	7680	10080	8960	9280
Water used in cooling and process (cu m per day)	15.5	15.0	15.0	15.0
Engine electricity efficiency (per cent)	35.4	39.2	39.2	39.2
ENERGY BALANCE				
Biogas consumption (cu m per day)	4800	6200	5200	5400
Electricity generation (kWh per day)	8300	13500	11200	11800
Auxiliary consumption (kWh per day)	560	850	840	990
Net electricity utilised for plant (kWh per day)	7740	12650	10360	10800
MAN POWER REQUIREMENT				
Electrical engineer	03	--	--	--
Fitter	01	--	--	--
Wireman	01	--	--	--
Baldar/cleaner	03	--	--	--
COST ECONOMICS				
Capital cost of equipment/machineries used for project (in lakhs)	245.46	625	617	621
First year operation and maintenance (O&M) (in lakhs)	15	--	--	--
Building cost of the plant (in lakhs)	17	--	--	--
Payback period (approx. in years)	--	4	5	5

varnish to contain around 600 cu m of sewage gas. This gas storage system helps to even out the fluctuations in the gas generation within the digester, if at all, during the day.

Automatic Biogas Flaring System

The biogas generated from the digesters contains methane gas as a major constituent, which is a GHG. In order to prevent the excess biogas from escaping into the atmosphere, an automatic biogas flaring system is provided which burns the biogas and reduces the emission of GHGs.

> **In order to prevent the excess biogas from escaping into the atmosphere, an automatic biogas flaring system is provided which burns the biogas and reduces the emission of GHGs.**

Biogas Blowers for Engine Generator Set

For efficient combustion to take place within the 100 per cent biogas fired engine, it is imperative to maintain certain minimum pressure of the biogas at the inlet of the biogas engine. Twin lobe type root blowers are provided just before the biogas engine to consistently maintain this parameter during the engine operation. These blowers are connected in such a way that it can suck biogas from the biogas holder and/or directly from digester.

Biogas Engine Generator Set

The biogas engine generator set is the main heart and soul of this power generation plant. The capacity of the installed biogas engine generator set is 1.0 megawatt electrical (MWe). The engine generator set is capable of operating with a wide variety of gases including, natural gas, sewage gas, landfill gas, etc. with minimal adjustments. The electrical efficiency of this engine generator set is 39.2 per cent at full load.

Supervisory Control and Data Acquisition System

Supervisory control and data acquisition system was installed for precise and efficient control over plant processes and to collect and store data generated from various field instruments such as the digester pressure transmitter, biogas flow meter, online CH_4 and online H_2S analyzer, pH meter for H_2S scrubber, electrical power analyzer, various engine generator set parameters, etc. The data is used to generate various customised reports to constantly monitor the plant condition and efficiency and to plan scheduled maintenance, etc.

Sewage Gas Power Plant SCADA & Control Room

H_2S Scrubber

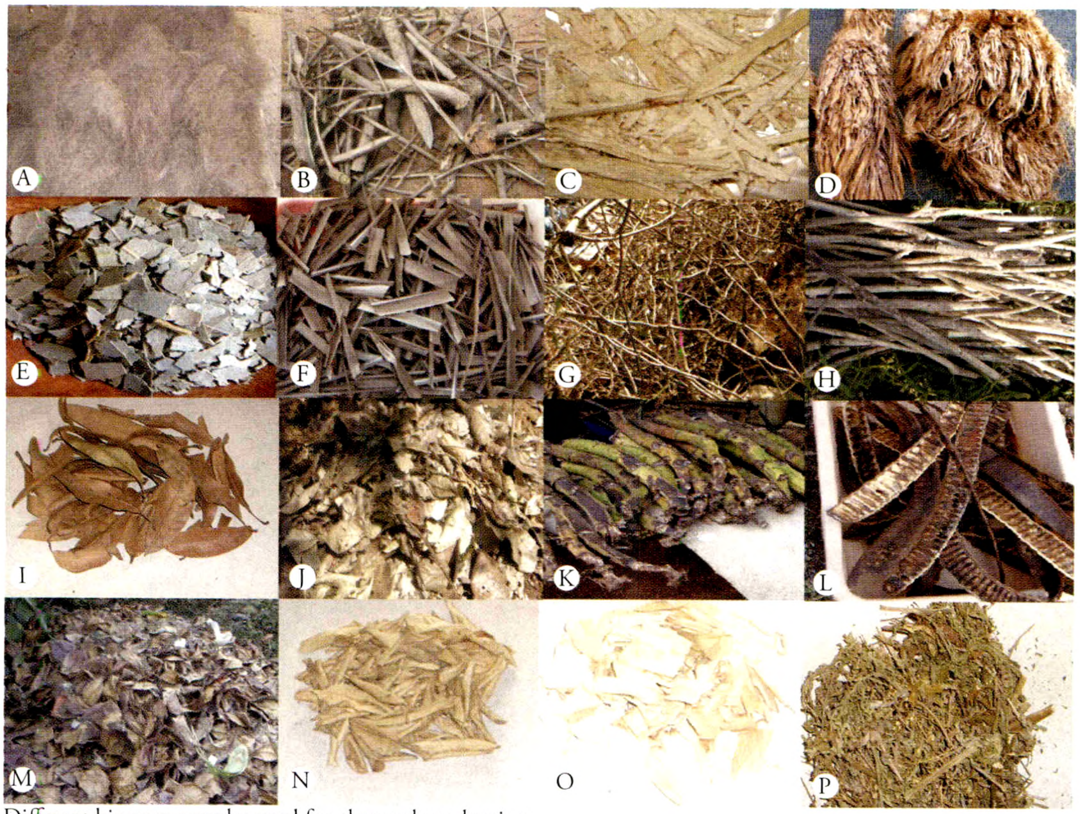
Waste Generation and its Disposal

The used scrubbing solution in the H_2S scrubber is the only waste generated in this power plant. Even this is so negligible that it can be diluted and treated along with the inlet sewage in the STP. Practically this power plant along with the STP is more or less a zero waste system.

Benefits Achieved

- Drastic reduction in emission of GHGs
- Generation of employment
- Saving of fuel and saving of revenue/earning. The non conventional biogas fuel has become a source of energy to generate electricity, thereby reducing the utilisation of grid power.
- Conservation of conventional fuels.

The author is Municipal Commissioner, Surat Municipal Corporation, Surat, Gujarat.



Different biomass samples used for charcoal production
A. casuarina leaf litter; B. lantana camara stem; C. sugar cane bagasse; D. oil palm fruit bunch; E. eucalyptus leaves; F. coconut leaves; G. prosopis twigs; H. ipomoea stem; I. mango leaves; J. teak leaves; K. banana empty fruit bunch; L. delonix regia fruit pod; M. almond leaves; N. lemon leaves; O. maize fruit sheath; P. parthenium plants.

Biomass Charcoal Briquettes

A boon for rural areas

Agricultural residue is an important biomass feed stock in India, the disadvantages of raw agricultural residue as an energy feedstock can be overcome by converting it into high density fuel briquettes - biomass charcoal briquettes.

Sugumaran P, Ravichandran P and Seshadri S

Today there is strong worldwide interest in the development of technologies that will enable the exploitation of renewable energy (RE) sources, both for environmental and economical reasons. Biomass, a domestic energy source is naturally abundant and presents promising RE opportunities that could provide an alternative to the use of fossil resources. The use of biomass feedstock(s) as alternative for fossil fuel(s) has an additional importance from climate change consideration, since biomass has the potential to be CO_2 neutral.

Agricultural residue constitutes an important biomass feed stock in India. In general, agricultural residue can be

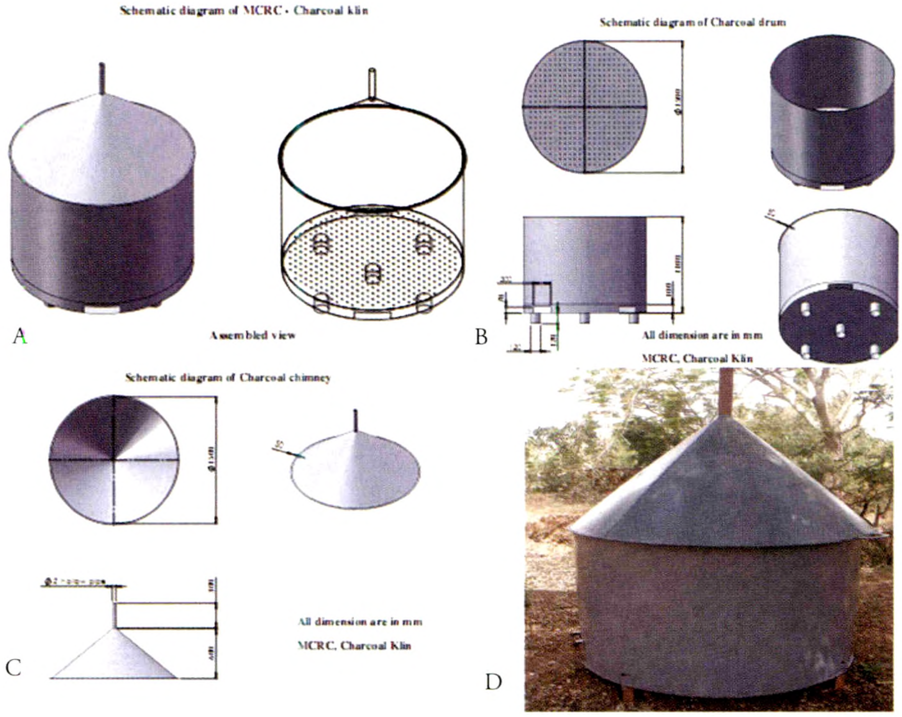

Schematic diagram of MCRC - Charcoal kiln
A
Assembled view
Schematic diagram of Charcoal drum
B
All dimension are in mm
MCRC. Charcoal Klin
Schematic diagram of Charcoal chimney
C
All dimension are in mm
MCRC. Charcoal Klin
D

Fig 1. Fabrication of charcoal kiln
A. Charcoal kiln assembled view; B. Kiln different view; C. Charcoal chimney; D. Fabricated metal kiln

divided into two groups, crop residue and agro-industrial residue. Raw agricultural residue has many disadvantages as an energy feedstock including relatively low calorific value, difficulty in controlling the rate of burning, difficulty in mechanising continuous feeding, requirement of large or area for storage, and problems in transportation and distribution. These disadvantages of raw agricultural residue as an energy feedstock can be overcome by converting it into high density fuel briquettes - biomass charcoal briquettes. Recent improvements in technology for charcoal briquettes production with increased efficiency has renewed interest in their use as a fuel that can easily be stored and transported.

Presented here is a comprehensive view on the development and standardisation of an appropriate eco-technology for the production of charcoal from different agricultural/industrial/forest wastes by conversion into fuel briquettes based on research conducted at the Shri AMM Murugappa Chettiar Research Centre (MCRC), Taramani, Chennai. The briquettes are prescribed as an alternative, cheap and cleaner fuel for cooking and generation of additional income for people in rural areas.

Biomass collection, characterisation and pyrolysis

Biomass collection and characterisation

Agricultural wastes such as sugarcane bagasse, oil palm fruit bunch, banana empty fruit bunch, maize fruit sheath and commonly available plants or their parts like casuarina leaf litter, *lantana camara* stem, eucalyptus leaves, coconut leaves, *prosopis* twigs, *ipomoea* stem, mango leaves, teak leaves, *delonix regia* fruit pod, almond leaves, lemon leaves and parthenium plants were collected from various places in Tamil Nadu and sun dried.

> **The calorific value of the different air-dried fresh biomass, carbonised char powders and wood charcoal was determined by using a bomb calorimeter.**

Proximate, ultimate and bio chemical properties of raw biomass such as ash, moisture, volatile matter, fixed carbon, hydrogen, oxygen, nitrogen and sulphur contents and cellulose, hemicelluloses and lignin as suggested by HD Goering et al. in *Forage Fibre Analysis* (1975) were determined using standard procedures as per the American Society of Testing Method - ASTM D3172 - 89, Standard Method of Proximate Analysis of Coal and Coke, (ASTM, USA) 2002.

Laboratory level carbonisation/pyrolysis

Biomass samples were chopped into small pieces, 10 to

Fig 2

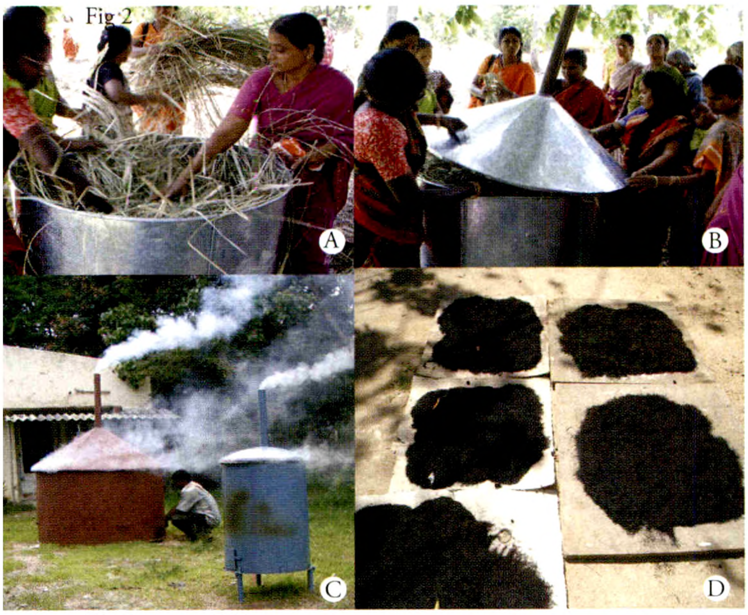


Fig 3

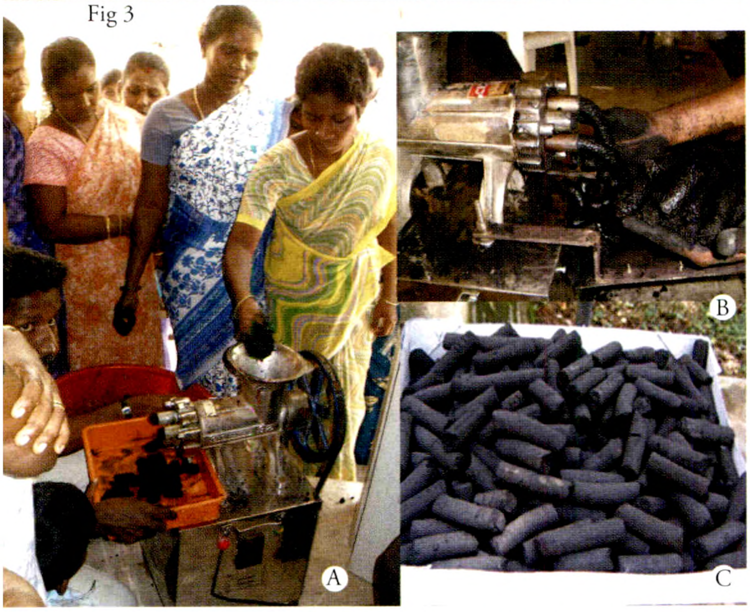


Fig 2. Large scale charcoal production using metal kiln
A. Biomass loading into kiln; B. Chimney fixing into filled kiln C. Carbonisation process; D. Carbonised charcoal

Fig 3. Briquettes production and drying
A. Charcoal loading into briquetting machine; B. Production of briquettes C. Dried biomass charcoal briquettes

> **The biomass charcoal briquetting technology can be viable in the long run as it is cost effective, eco friendly, improves air quality and supports rural economies.**

15 cm in size and pyrolysed in a muffle furnace at 200°C, 300°C, 400°C, 500°C and 600°C, then they were cooled and the carbonised char was weighed. It was found that an increase in temperature from 200 to 600°C gradually decreased the char yield.

Calorific value analysis

The calorific value (the calories or thermal units contained in one unit of a substance and released when the substance is burned) of the different air-dried fresh biomass, carbonised char powders and wood charcoal was determined by using a bomb calorimeter. The calorific value of the selected biomass was found to be ~40 per cent higher after carbonisation.

Large scale carbon production

Fabrication of charcoal kiln

A large size charring kiln or drum made up of a portable cylindrical structure with the top cut out to place the chimney was fabricated. The height of the metal drum was 100 cm, width was 150 cm and it was made up of 1.6 mm thick MS (mild steel) sheets. Two fire ports with doors (12" height x 20" width) were provided at the bottom. Above the firing portion, an iron perforated sheet with evenly distributed holes (3 mm) was placed. The bottom portion of the drum was closed with iron sheets and provided with 4 legs (Fig 1).

Charcoal production and yield evaluation

100 kg of biomass samples were loosely packed into the drum, lit with fire to start the carbonisation process, and allowed to burn slowly (Fig 2). After the carbonisation process was over (~ 1-2 hrs depending upon the biomass), the lid was opened and water was sprinkled over the char. The char powder collected was used in the preparation of briquettes. Though, the carbonisation process produces 30-45 per cent char powder on an average, the char yield was found to vary according to the biomass used.

Production of charcoal briquettes

Fabrication of a briquetting machine

A meat mincer mould along with a 1 horse power (HP) electric motor fitted appropriately was used as a briquetting machine. The briquetting machine consisted of two portions - the lower and upper portion. The lower portion was fitted with a 1 HP single-phase electric motor fixed onto a wooden platform. The upper portion was fitted with the meat mincer (model no. 32, cylindrical type; 10 kg per hr), that acted as a briquetting mould with an outlet fixed to a wooden plate placed 1 ft above the lower wooden platform.

Both the plates were fitted into an iron angle and all the sides were covered fully by stainless steel sheets. In the front side of the briquetting machine, a power indicator and one 15 amps switch were fitted.

Production of Briquettes

Selection of binder for briquette preparation

The char powder was mixed with cost effective binders like starch in the ratio of 10:1 and fuel briquettes were prepared using the briquetting machine.

Briquetting, drying and packing

The charcoal mixture with a suitable binder can be made into briquettes either manually or using the briquetting machine. For the mechanical operation, the mixture was loaded into the machine directly to produce uniform-sized cylindrical briquettes. The briquettes were collected in a tray, and later sun dried for 2 or 3 days before packing in sealed plastic bags (Fig 3).

Briquettes as alternative fuel

The biomass charcoal briquettes can be used efficiently in rural houses for cooking, in laundries for ironing, in small teashop boilers and tandoor *chulhas* in small hotels.

Conclusion

Biomass charcoal briquette production technology can not only be one of the solutions for supplementing the fuel requirements in rural areas but can also serve as a developmental model for efficient biomass waste management and utilisation by providing part time/alternative employment to people in rural areas. Though capital intensive, the biomass charcoal briquetting technology can be viable in the long run as it is cost effective, eco-friendly, improves air quality and supports rural economies. Since the technology advocates the use of biomass wastes as substrate, natural forests would be saved.

Acknowledgments

The authors thank Department of Science and Technology (DST) and Department of Biotechnology (DBT), New Delhi for providing financial assistance for the development and dissemination of the technology and Shri AMM Murugappa Chettiar Research Centre (MCRC), Taramani, Chennai for providing necessary facilities to carry out the research work. ❂

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Government of India
Ministry of New & Renewable Energy (MNRE)

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Solar Energy Corporation of India (SECI), New Delhi
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Inviting articles for Akshay Urja

The need to have a sustainable supply necessitates the exploitation of available energy sources, and among these, renewable resources are at the forefront. It is now an established fact that renewable energy (RE) can be an integral part of sustainable development because of its inexhaustible nature and environment-friendly features. RE can play an important role in resolving the energy crisis in urban areas to a great extent. Today RE is an established sector with a variety of systems and devices available for meeting the energy demand of urban inhabitants, but there is a need to create mass awareness about their adoption. Akshay Urja is an attempt to fulfil this need through the dissemination of 20,000 copies in India and abroad. The magazine publishes news, articles, research papers, case studies, success stories, and write-ups on RE. Readers are invited to send material with original photographs and statistical data. The photographs should be provided in high resolution files on a CD or through email. Akshay Urja will pay a suitable honorarium to the authors for each published article of 1500 words and above. The publication material in two copies, along with a soft copy on CD/DVD/e-mail may be sent to

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Don't Kill Our Silent Friends The Trees!

The Prakratik Society has installed biogas digesters in villages around the Ranthambore National Park, which produce clean and safe biogas for cooking from cattle manure and thus save the forests in the process.

Ranthambore National Park is one of the biggest and the most renowned national parks in Northern India. The deciduous forest bounded by rivers on the north and south is home to the Indian tigers which attract tourists from all parts of the globe. There are number of villages around the Park with a significant poor population. The villagers depend on fuel wood for cooking. The visible deforestation all around the park suggests that the demand far exceeds sustainable supply. With the increase in population at an alarming rate of 3.2 per cent per year, the need for fuel wood also increases.

A non government organisation (NGO), Prakratik Society, came up with a solution to this problem. The organisation installed 250 biogas digesters in villages around the Park. These digesters produce clean and safe biogas for cooking from cattle manure and thus save fuel wood in the process. The digester output is used as fertilizer. The technology greatly reduces the emission of carbon dioxide and carbon monoxide from the burning of fuel wood and thereby minimises the impact on the environment.

Action for Food Production (AFPRO) in Delhi developed the Deenbandu model of digesters in 1984 as an improvement over the Janta model; this same model was used at Ranthambore. This digester is a round tank with a volume of about 3 cu m. The tank is made up of brick and mortar and is sunk in a pit. A hand-operated rotator, installed at the inlet of the tank is used to mix cow dung and water. The slurry of dung and water gets decomposed in the tank and finally comes out of the outlet due to the pressure exerted by the biogas which is produced in the process. The biogas is taken from the top of the tank to a biogas cooking stove through a pipe. The slurry is collected and used as fertilizer.

The reliability of the technology alone cannot ensure long term usage of biogas as there are several instances where such plants were successfully installed and later abandoned. In order to eliminate such a possibility, Prakratik Society selected those families who will find the use of the technology beneficial for them, over a long period. Since the digester needs the manure of at least four cattle to operate well, the selection of families was also based on the number of cattle they own. These families fall under the middle income group, and they represent about half of the total population of about 2 lakh people in the 96 villages around Ranthambore.

The aim of the project was to build at least one digester in each village, so that all villagers have the opportunity to see the technology in action. The idea was quite effective as a large number of villagers later requested for new biogas plants after observing the benefits of the installed ones. Besides financial support, the families also extended support in the form of unskilled labour to construct the digesters. The biogas digester installation programme started in 1999, and by March 2004 the organization had installed 250 digesters.

The Prakratik Society was founded in 1994 by Dr Goverdhan Singh Rathore, who was aware of the poverty of the villagers and at the same time was eager to save the Park from deforestation. The technology and the resulting project addressed both the issues. There is tremendous growth potential of this technology within the State and in the entire rural India at large. Awareness is the key for which Prakratik Society works closely with local NGOs involved in afforestation. It also works with NGOs around other National Parks in India, to encourage the development of similar programmes. School children from other park areas are encouraged to visit Ranthambore and its surrounding villages so that they can learn about the benefits of biogas digesters.

One of the major contributions of biogas is to reduce the consumption of fuel wood. Considering the average daily fuel wood consumption as 1.1 kg per person, a digester used by a typical family of 6 people saves about 2.4 tons of fuel wood per year. The installed 250 digesters therefore save about 600 tons of wood per year. Smoke is generated when wood is used as fuel for cooking. The inhalation of this smoke works as a major cause for eye diseases, respiratory illnesses and premature death. The use of biogas clearly reduces smoke and keeps the kitchen atmosphere clean. Poor villagers in the Park's fringes also get relief from an extensive search for wood, which sometimes involves a trip of 20 km. Also, biogas reduces the emission of carbon monoxide and other products of incomplete combustion. The estimated saving of emission from each digester is equivalent to about 4.7 tons of carbon dioxide per year.

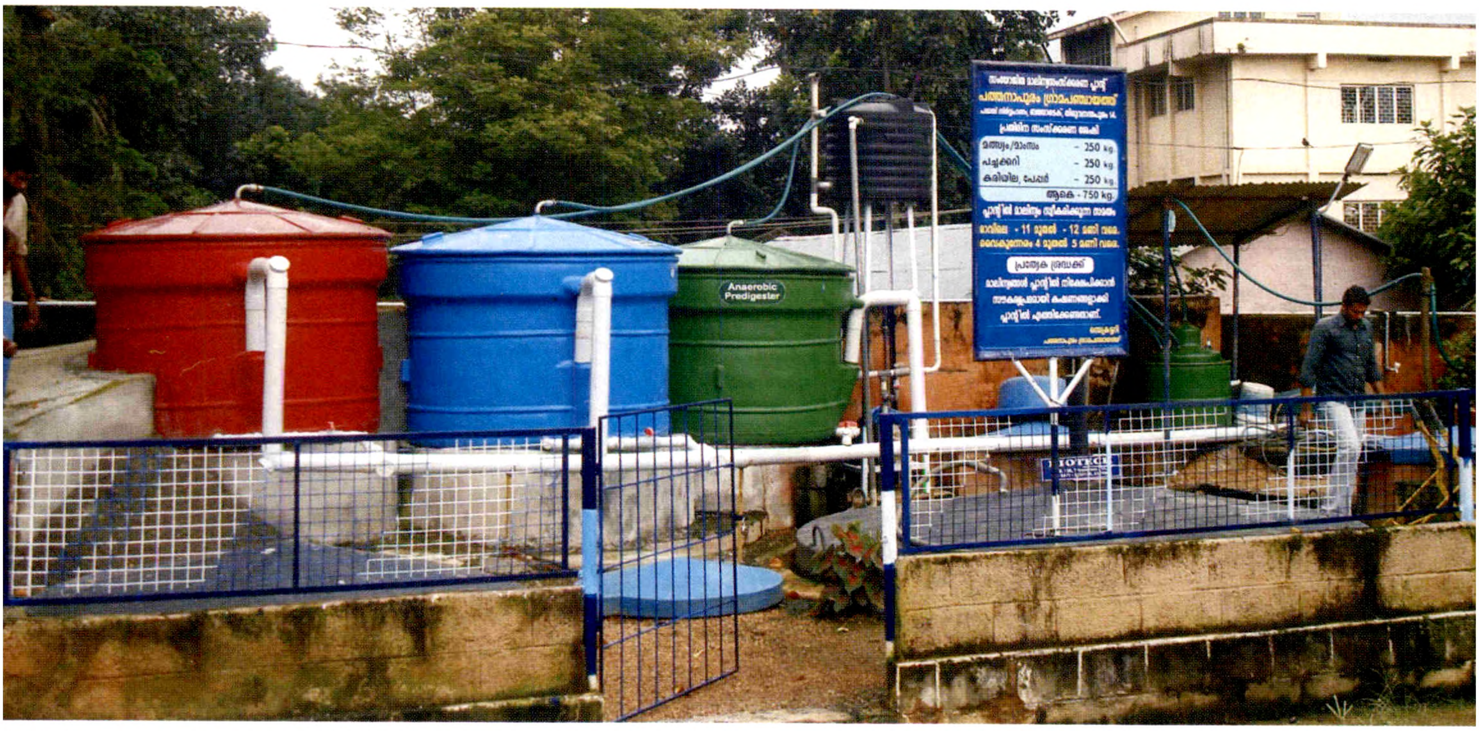
Construction underway in village Soorwal

Prakratik Society also supports better husbandry of cattle, through a programme of artificial insemination and the encouragement of tethered feeding for cattle for certain periods. This has increased milk production besides maintaining an accessible supply of manure to run the digesters. The output slurry from the digesters is an excellent organic fertilizer, which produces good crops and saves money on purchase of fertilizer. If sold, the fertilizer from each digester can yield about INR 10,000 per year. To provide seedlings for the development of agro-forestry in the villages around the Park, the organisation has also started a nursery. This further provides fodder for cattle, timber for furniture and a supply fuel wood for those who do not have access to biogas digesters. Lack of awareness amongst the people is the main hurdle for the propagation of this technology. Until this project, most people around Ranthambore were dependent on fuel wood from the park which was illegal but free. A lot of effort had to be made to convince them that although the initial cost is high, it will result in benefits in the end. The other constraint was to find space near their homes to build the unit as the proximity of cattle and water source is important from the standpoint of supply of raw materials to the plant. The technology has a lot of potential and can really flourish if proper awareness campaigns can be launched across entire rural India.

Source : Access to Clean Energy, A book published by MNRE.

Let's not Waste Our Waste!

BIOTECH, an NGO based in Kerala, has developed biogas digesters which capture food waste, other organic waste and waste water at source and produce biogas through a technology called biomethanation.



Kerala is known for its timeless beauty - the palm fringed beaches, the majesty of the undulating hills and the serenity of the pristine backwaters. The State is on a prosperous track and observes a steady growth of middle class population. The suburban areas demand a clean and hygienic disposal of waste from homes, institutions and municipalities as opposed to the rural practice of leaving out waste for animals. Many local councils operate services to collect waste from doors, but the stray animals in search of food often tear open rubbish sacks kept outside, and thereby create more litter.

Unhealthy situations arise due to the absence of proper waste management system at the source of waste generation. Consequently they create a perennial problem for the local administration authority like the Panchayat, municipality and corporation; who look for an effective way to create and maintain clean and hygienic public places. BIOTECH, a non governmental organisation (NGO) based in the State, has come up with a solution to the problem. It has developed biogas digesters which capture food waste, other organic waste and waste water at source and produce biogas through a technology called biomethanation.

The organic materials are put into airtight vessels where bacteria break them to release biogas. This gas is a mixture of methane and carbon dioxide with the percentage of the latter being less. The biogas can either be burned directly as a cooking fuel or can be used to generate electricity after purification. The solid residue can be used as an organic compost. BIOTECH has developed plants of 6 different sizes to cater to 3 different sectors; i) Domestic (individual households); ii) Institutions (schools, hostels, hospitals, hotels); and iii) Local councils (market places).

The standard domestic plants with volume of 1 cu m produce about 1 cu m of biogas per day with a maximum daily input of 5 kg solids and 20 lt of organic waste. The digester vessel is made up of two components; i) a precast (from ferro-cement) digester tank sunk into the ground; and ii) a gas holder drum constructed from fibreglass reinforced plastic (FRP) which floats over the tank. BIOTECH also manufactures portable digesters that stand on the surface, to install in areas where excavation is impossible or undesirable due to reasons such as high water-table.

Food waste, the main feed stock for the plant is mixed with organic waste water from the kitchen in a bucket and fed into the plant inlet with no additional water. Cowdung is used initially to provide a culture of suitable bacteria, which triggers the digestion process. The biogas evolves with decomposition of waste, gets collected in the gas-holder and is finally taken to a special biogas stove in the kitchen through a pipe connected with the gas-holder. A valve is used to open and shut the flow and a regulator varies the flame. Nearly 22,000 domestic plants have been installed serving 88,000 people. This includes quite a few plants that have latrines connected.

The biogas plants in schools and hostels are bigger than the domestic ones. With a capacity range of 10 cu m to 25 cu m, each plant on an average can serve about 200 people. About 200 institutional plants have been constructed to manage kitchen waste, and a further 22 include latrine connections as well.

The large scale energy-from-waste plants are built from one or two 25 cu m biogas digesters and are installed for local councils or fish markets. Dry bio-degradable waste, glass, plastic etc. are sorted out by hand from the overall municipal waste and sold for recycling. The wet waste is then fed into the biogas plant. To speed-up the digestion process, the organic waste is broken down to a uniform size by a mechanical chopper. Water separated from the output slurry can be recycled by mixing it with the feed material. The biogas produced in the process is used to generate electricity with the help of generators. BIOTECH has completed 52 such projects.

BIOTECH was founded in 1994 and promotes biogas technology through its participation in symposia, seminars, exhibitions and demonstrations at the State and national level. It has its own workshops where it manufactures all the plants maintaining high quality.

The main benefit of BIOTECH plants is that they provide clean disposal route of food waste from households and institutions.

BIOTECH is experiencing an increasing demand for domestic scale systems. With nearly 30 per cent urban population in the country, there is a huge growth potential of this technology. In rural areas too the potential is considerable, provided Panchayats work on creating awareness among people and arrange for budgets. However, the greater potential is possibly at the municipal level, where there are serious public health risks from large volumes of organic waste, including pollution of water supplies.

The main benefit of BIOTECH plants is that they provide a clean disposal route for food waste from households and institutions and huge amount of organic wastes from markets and councils and thus prevent the release of methane from uncontrolled decomposition of waste. Latrine connected plants help to avoid contamination of ground water with human sewage. Additionally, all these plants produce clean biogas which partially replaces LPG firewood as cooking fuel and in turn cut down CO_2 emission. Biogas from domestic plants replaces about 50 per cent of LPG use and thus saves a family about INR 2,280 per year. This means that the family can recover its share of the cost of the plant in about 3 years. Institutional plants with latrines attached replace 50 to 75 per cent of their LPG use, through additional biogas production from the sewage waste. Energy-from-waste plants generate 3 kW to 5 kW of electricity from biogas which is used for lighting the market and adjoining areas. The biogas works as an advanced and convenient means for cooking in rural areas where most cooking is done using firewood or kerosene. Biogas is also safer than LPG for cooking, because it cannot be lit accidentally by a spark. The odourless effluent from the plant is used as garden fertilizer as it contains high percentage of nitrogen, phosphorus and potassium. ✪

Source : Access to Clean Energy, A book published by MNRE.

National

9 - 11 January 2012	Indo-Japan Conference on Frontier Nanomaterials for Energy (FNE-2012) Place: Greater Noida, Uttar Pradesh Organiser: School of Engineering and Technology, Sharda University Contact: (0120) 232 3602 or info.fne2012@sharda.ac.in Website: www.sharda.ac.in
1 - 3 February 2012	International Multi Disciplinary Conference on Solar Energy (IMDCSE 2012) Place: Chennai, Tamil Nadu Organiser: Meenakshi Sundararajan Engineering College Contact: (044) 2480 1636 or convener@imdcse.org Website: www.imdcse.org
2 - 4 February 2012	Fifth National Conference on Advances in Energy Conversion Technologies (AECT 2012) Place: Manipal, Karnataka Organiser: Manipal Institute of Technology Contact: (0820) 292 5121 or aect2012@manipal.edu Website: http://conference.manipal.edu
6 - 10 February 2012	National Conference on Energy Efficient Design Buildings: Seeking Cost Effective Solutions Place: Murthal (Sonepat), Haryana Organiser: Deenbandhu Chhotu Ram University of Science and Technology Contact: (0130) 248 4010 or creedps.arch@dcrustm.org Website: http://dcrustm.ac.in
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International

13 - 14 February 2012	EnerCan West: Energy and the Environment Place: Regina, Canada Organiser: Saskatchewan Environmental Industry and Managers Association Contact: +1 780 436 0983 ext. 257 or Maureen@buksa.com Website: http://enercanwest.com
16 - 19 February 2012	TerraGreen12 Place: Beirut, Lebanon Organiser: TerraGreen Contact: secretariat@terragreen.org Website: www.terragreen.org
21 - 23 February 2012	Energy Indaba 2012 Place: Johannesburg, South Africa Organiser: Siyenza Management Contact: +27 11 463 9184 or info@siyenza.za.com Website: www.energyindaba.co.za
22 - 23 February 2012	3rd Annual Renewable Energy Finance & Infrastructure Summit Place: Vienna, Austria Organiser: Fleming Europe Contact: +421 257 272 333 or info@flemingeurope.com Website: http://energy.flemingeurope.com
26 - 28 February 2012	2012 2nd International Conference on Future Environment and Energy (ICFEE 2012) Place: Singapore Organiser: CBEE Contact: icfee@cbees.org Website: www.icfee.org
29 February - 1 March 2012	Asia Energy Security Summit Place: Colombo, Sri Lanka Organiser: IPPAI Contact: +91 11 49556614 or iqbal@ippaimail.org Website: www.asiaenergysecurity.com

Website

Global Bio Energy Partnership (GBEP)

www.globalbioenergy.org

GBEP brings together public, private and civil society stakeholders in a joint commitment to promote bio energy for sustainable development. The GBEP focuses its activities in three strategic areas: Sustainable Development, Climate Change, Food and Energy Security.

The purpose of the GBEP is to provide a mechanism for partners to organize, coordinate and implement targeted international research, development, demonstration and commercial activities related to production, delivery, conversion and use of biomass for energy; with a focus on developing countries.

The Bio Energy Site

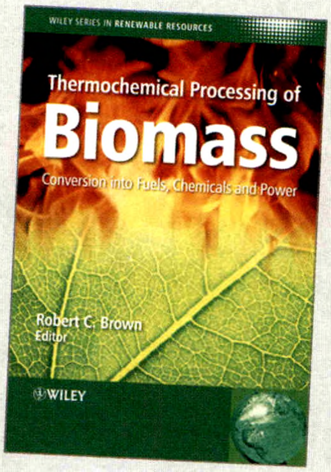
www.thebioenergysite.com

This web site is devoted to the global bio energy industry from a farming/agricultural perspective. It is a provider of free technical information to a steadily growing on-line worldwide audience. Updated daily, the site comprises several different sections and lists, industry and company news, technical articles, upcoming events, and the latest discussion threads.

The Biodiesel Association of India (BDAI)

www.bdai.org.in

BDAI is non profit national association representing the biofuels sector more specifically biodiesel industry as the coordinating body for marketing, research and development in India. It aims to encourage biofuels specially biodiesel and to assure sustainable agricultural growth, rural development, energy security and equal opportunity for the masses with overall environmental protection.


WILEY SERIES IN RENEWABLE RESOURCES
Thermochemical Processing of
Biomass
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Robert C. Brown
Editor
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Thermochemical Processing of Biomass: Conversion into Fuels, Chemicals and Power

by **Robert C Brown (Editor) and Christian Stevens (Series Editor)**
Hardcover: 348 pages
Pound 85.00
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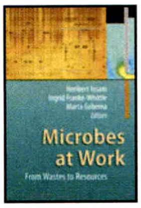
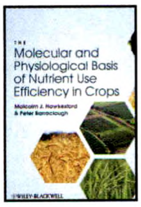
ISBN: 978-0-470-72111-7

Thermochemical pathways for biomass conversion offer opportunities for rapid and efficient processing of diverse feedstocks into fuels, chemicals and power. This book examines the large number of possible pathways for converting biomass through the use of heat and catalysts and highlights the fundamental chemistry, technical applications and operating costs associated with thermochemical conversion strategies. It would be useful for engineering professionals in the biofuels industry, as well as academic researchers working in bio energy, bioprocessing technology and chemical engineering.



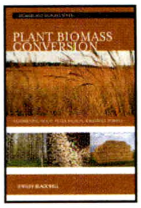
Microbes at Work From Wastes to Resources

by **Heribert Insam, Ingrid Franke-Whittle, Marta Goberna (Editors)**
Hardcover: 329 pages
Euro 160.45
Publisher: Springer Verlag, Heidelberg, Germany 2010
ISBN: 978-3-642-04042-9



The Molecular Basis of Nutrient Use Efficiency in Crops

by **Malcolm J Hawkesford and Peter Barraclough**
Hardcover 512 pages, Pound 130.00 Publisher: Wiley-Blackwell, July 2011
ISBN: 978-0-8138-1992-1



Plant Biomass Conversion

by **Elizabeth E Hood, Peter Nelson and Randall Powell (Editors)**
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March 2011
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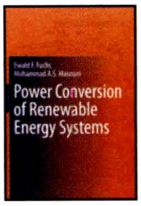
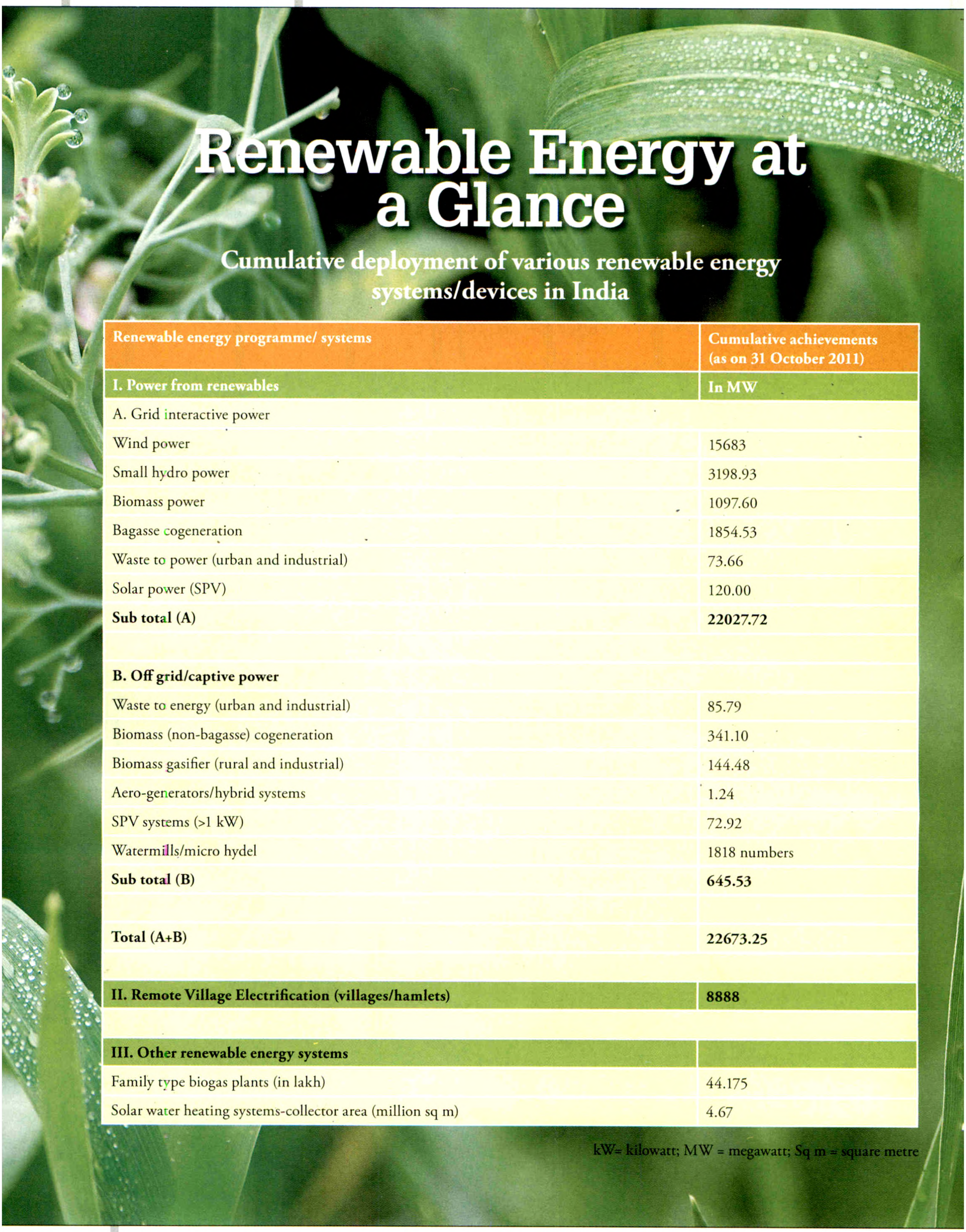


Power Conversion of Renewable Energy Systems

by **Fuchs, Ewald F, Masoum and Mohammad AS**
Hardcover 692 pages
Euro 69.95
Publisher: Springer,
Year 2011
ISBN: 978-1-4419-7978-0



Renewable Energy at a Glance

Cumulative deployment of various renewable energy systems/devices in India

Renewable energy programme/ systems	Cumulative achievements (as on 31 October 2011)
I. Power from renewables	**In MW**
A. Grid interactive power	
Wind power	15683
Small hydro power	3198.93
Biomass power	1097.60
Bagasse cogeneration	1854.53
Waste to power (urban and industrial)	73.66
Solar power (SPV)	120.00
Sub total (A)	**22027.72**
B. Off grid/captive power	
Waste to energy (urban and industrial)	85.79
Biomass (non-bagasse) cogeneration	341.10
Biomass gasifier (rural and industrial)	144.48
Aero-generators/hybrid systems	1.24
SPV systems (>1 kW)	72.92
Watermills/micro hydel	1818 numbers
Sub total (B)	**645.53**
Total (A+B)	**22673.25**
II. Remote Village Electrification (villages/hamlets)	**8888**
III. Other renewable energy systems	
Family type biogas plants (in lakh)	44.175
Solar water heating systems-collector area (million sq m)	4.67

kW= kilowatt; MW = megawatt; Sq m = square metre